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Educational Scientific Toys for Children of 5-10 Years

(Theoretical-practical research)

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ABSTRACT

Educational scientific toys for children of five - ten years are the simplest and interesting way to involve children into science and to show what science is. The world of science is close to the world of toys. Science for children is one of the social initiatives all over the world. Such well-known companies like Science4youtoys, Clementoni, Tedcotoys, Curiousminds, EDU-toys and others already successfully embody science in the toys, but the world of science is unlimited, as well as the limitless world of toys.

The purpose of this work is to develop and implement an object (or group of objects) for children from five to ten years that allows in a simple and entertaining way to attach children to the complex world of science. In this research we consider the main issues necessary for the development of educational scientific toys such as materials, technology, ergonomics, psychological characteristics of children and other.

This is a theoretical - practical research with mixed methodology.

KEYWORDS

- Children, their skills and abilities;
- Product Design (Toy);
- Science;
- Materials & Technology;
- Safety.

DIAGRAM. STATE OF THE ART

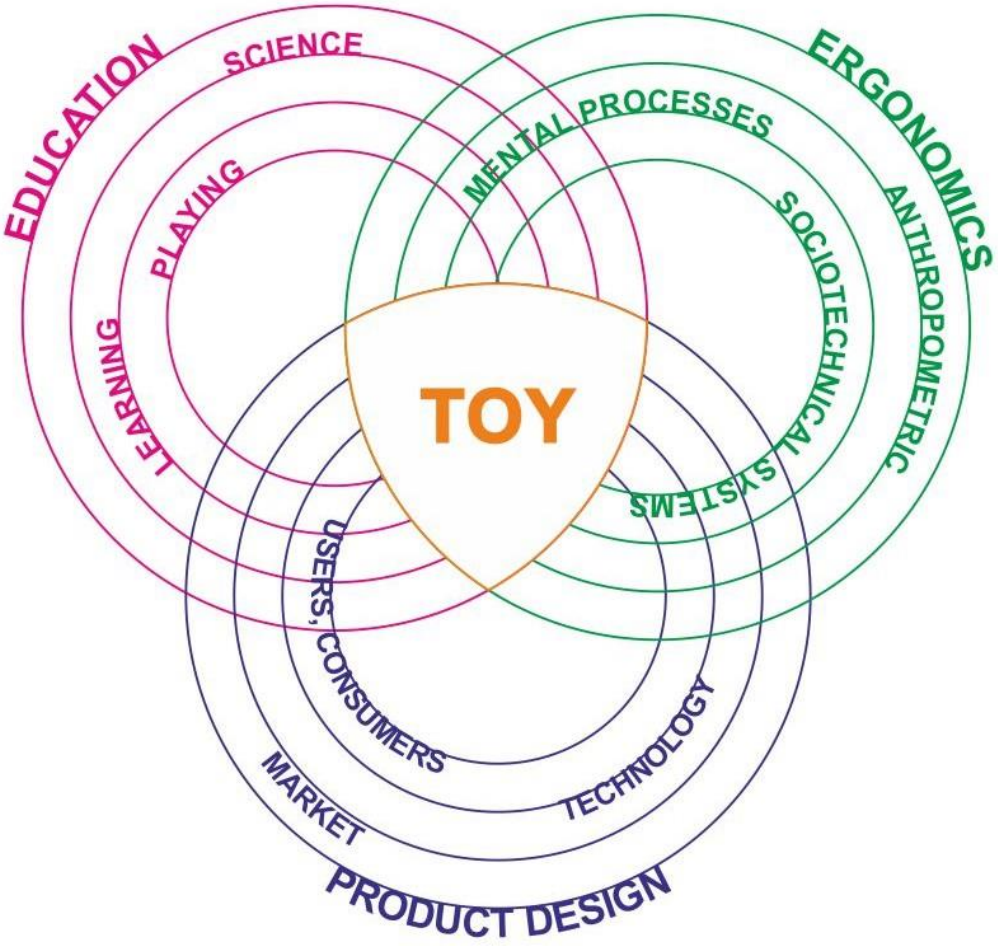

Figure 1 - Diagram State of the Art (N. Lygina, 11.11.2014)

GLOSSARY

Affordance - interaction between man and technical devices; communication between designer and consumer.

Attention - the element of cognitive functioning in which the mental focus is maintained on a specific issue, object, or activity.

Cognition - the higher mental processes, including understanding, reasoning, knowledge, and intellectual capacity.

Intellection - the act or process of using the intellect; thinking or reasoning.

Language - a system of signs, symbols, gestures, or rules used in communicating.

Memory - the ability of the brain to retain and to use knowledge gained from experience, it is essential to the process of learning.

Motor skills - is a sequence of movements, which together are needed to perform a specific task.

Perception - the mental process of recognizing and interpreting an object through one or more of the senses stimulated by a physical object.

Trend - is a general direction of change: a way of behaving, proceeding, etc. that is developing and becoming more common.

ACRONYMS AND ABBREVIATION

DNA - deoxyribonucleic acid

NSF - The National Science Foundation

STEM - science, technology, engineering, and maths

TEDCO - Teetor Engineering Development Company

Zamak - zinc, aluminum, magnesium and copper

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INTRODUCTION

Tell me and I will forget. Show me and I will remember. Involve me and I will understand. (Confucius around 450 BC)

Educational Scientific Toys for Children of 5-10 Years

It is no secret that science has an impact on our everyday life. Phenomena of physics, chemistry, biology and other sciences are all around us every minute. Undoubtedly, not only adults but also children need deep knowledge in the field of science.

As we know, science is a complicated thing. It is difficult to understand and explain, but if you find the right approach, everything can be easy and fun, accessible and interesting even for children! However, the question of how to bring scientific knowledge to children is still relevant, children are ready to acquire knowledge, but during the game, in an easy manner.

That is why we want to develop scientific educational toy for children from five to ten years, because, according to expert's opinions, this is the best age to receive knowledge, to ask questions and to get answers. We find it interesting to work with and for children, so we hope that this work will prove effective and positive way. It will be a theoretical - practical research. We want to use knowledge from the field of chemistry or physics because there you can find a lot of visual experience that certainly helps when dealing with children. Additionally, these are sciences of the future.

Scientific toys are the main object of our research, because these toys are the most simple and interesting way to involve children into science, to show them what science is. The world of science is close to the world of toys, that is why modern scientific toys actively use items of historical designs such as the invention of Hero, Archimedes, Leonardo da Vinci and other. Science for children is one of the social initiatives all over the world. Such well-known companies like Science4youtoys, Clementoni, Tedcotoys, Curiousminds, EDU-toys and others successfully embody science in the toys, but the world of science is unlimited, as well as the limitless world of toys.

To create a scientific educational toy, it is necessary to trace the history of its development as well as to orient at the current scientific situation. It is important to know the existing market of scientific toys, price and cost of similar products. It is also crucial to consider the psychological characteristics of children from five to ten years, their basic skills and abilities. Toys should contribute to the development of the child so it must be

functional and ergonomic. The choice of material is also a matter of principle for the manufacture of toys. Recently technologies become the main trend in the toy market. Toys are becoming more technical, electronic, and more intelligent. This allows us to use toys with the maximum result for development of the child.

Research question:

- How to design a toy that on one side is interesting and fun and on the other side allows to involving children in the complex world of sciences?

Research area:

Product Design. Scientific Toys

Kind of research:

Theoretical – Practical Research

OBJECTIVES

General:

- To design and implement an object (or group of objects) for children of five - ten years that gives the opportunity to develop the intellectual, cognitive and creative abilities of children.
- To design and implement an object (or group of objects) for children of five - ten years that allows in a simple and entertaining way to attach children to the complex world of science.

Specific:

- To use scientific knowledge (in physics, chemistry, etc.) in order to create developmental, cognitive, scientific object (group of objects) for children of five - ten years.
- To use knowledge of child psychology in order to create interesting and funny object (group of objects) for children of five - ten years.
- To develop object (group of objects) in accordance with requirements of safety of toys.
- To develop cheap object (group of objects) for children of five - ten years.

PRODUCT DESIGN

As we know ***«design in all its forms is the DNA of an industrial society…This is the code that should be studied in order to be able to understand the modern world»*** (Sudjic 2009, 34). Let us define components of this code.

Talking about the design, Victor J Papanek, designer and educator, represents design as a hexagon (Papanek 1984).

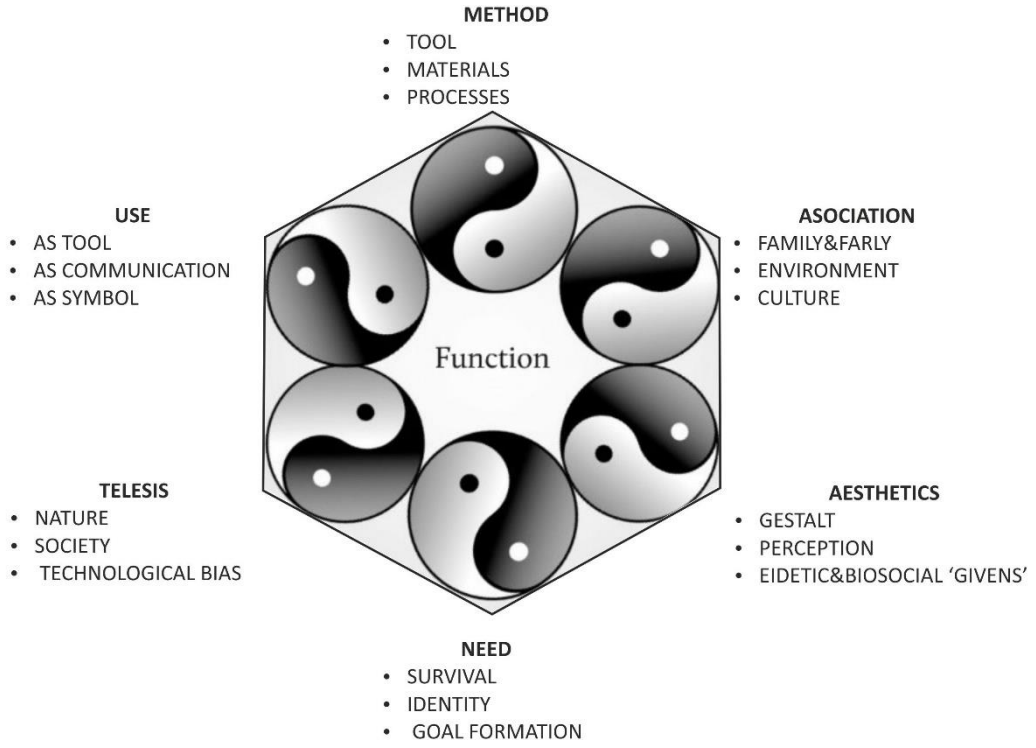


Figure 2 - Victor Papanek. Design function complex (Papanek 1984, 18)

According to Papanek (Papanek 1984) «Method» is the interaction of tools, processes and technologies. The most important thing is the optimal use of these components. A good method is «*never using one material where another can do the job less expensively and/or more efficiently»* (Papanek 1984, 7)**.** «Use» is a category that should answer the question does it work? When we talk about «Need», we must answer the question, do we really need it?, because «*much recent design has satisfied only evanescent wants and desires, while the genuine needs of man have often been neglected by the designer»* (Papanek 1984, 9)**.** The next category is «Telesis», i.e. the use of processes in nature and society. «*The telesic content of a design must reflect the times and conditions that have given rise to it, and must fit in with the general human socio-economic order in which it is to operate»* (Papanek 1984, 11)**.** *«*Association» or psychological aspect also plays an important role for the designer. «*Our psychological conditioning, often going back to earliest childhood memories, comes into play and pre- disposes us, or provides us with*

antipathy against a given value» (Papanek 1984, 12)**.** Finally, «Aesthetics». It is a tool, one of the most important for the designer, *«a tool that helps in shaping his forms and colours into entities that move us, please us, and are beautiful, exciting, filled with delight, meaningful»* (Papanek 1984, 14)**.**

Richard Buchanan, Professor of Design, Management, and Information Systems at the Weatherhead School of Management, sees design as a triangle (Buchanan 2011). There are three main criteria for modern design: if it is useful, if it is usable and if it is desirable. Product design is a balance of these three aspects. Useful is something that is connected with content, for example, engineering and technology. Usable by Buchanan refers to the social sciences, such as history and psychology. Desirable it is something from field of art especially in such areas as anthropology and sustainability.

It is obvious that aspects of Papanek (Papanek 1984) and Buchanan (Buchanan 2011) in tune with each other. Thus, we have determined the structure of the design. However, what are the basic principles of design?

The design should be user-oriented. It is one of the basic principles of the design. According to experts such as the Papnek (Papanek 1984) or Norman (Norman 2000), for good design we need to have at least four stages. First we should understand how people will interact with the product, what kind of potential problems may arise. To do this it is necessary to explore the users, their activity, and their environment. We need to take into account «*ergonomic, cognitive, social, and cultural factors that can affect usability and adoption of the technology being built»* (Souza 2004, 48). Then we should find possible solutions of potential problems. After we have to develop a prototype, making sure that it solves voiced potential problems and not creates new. Finally, it is necessary to test prototype. This is stage when the user «*finally makes full sense of the message*» (Souza 2004, 48). We need to use the psychology of people to create products adapted to their needs and desires. To make thing easy to use, we should eliminate all possible incorrect actions, that is, in the opinion of Norman (Norman 2000), to limit their choice.

Continuing the conversation about user- oriented design, Clarisse Sieckenius de Souza, who deals with human computer interaction, indicates: «*the design model is projected by the system image, which users must understand and interact with to achieve their goals. Thus, the system image is the ultimate key to success. If the design model is conveyed through the appropriate system image, which rests on familiar concepts and intuitive relations, users can easily grasp and remember how the system works… On the semiotic engineering side, the designer herself is present at interaction time, telling the user about her design vision, to which the user will respond in various ways (including unexpected and creative ways)»* (Souza 2004, 30)**.** In other words, we are dealing with «affordance».

Originally, «affordance» assumed as interaction between man and technical devices (Norman 2009). However, in recent years the specialists put in this concept a slightly different meaning. In modern interpretation, affordance is communication between designer and consumer (Souza 2004). When we talk about communication between designer and consumer, we think about the dialogue. Designer is one of the main participants of these relationships. The main task of the designer is to bring the idea to the consumer and if the user does not understand how should operate this or that object, it is a problem of the designer, who was unable to tell the idea in simple terms. Therefore, a good designer will do everything to convey his/her idea using all available means.

To have a dialogue between designers and consumers, they should be in the general context. That is why when people interact with each other, they often unconsciously follow a number of unwritten rules and understandings. Here are a few of these rules:

- Complex and natural system of signals.
- Predictability.
- A good conceptual model.
- Clear information.
- Natural correspondence, that gives the opportunity for an enjoyable and effective interaction. (Norman 2000).

The user is no less important participant of the dialogue and to get feedback from users is a very important part of the design process.

Special attention within the design process should be given to technologies, that every day fill our lives more and more intensively. Technology develops rapidly and sometimes we cannot keep up with them. Therefore, it is very important for technology to have a dialogue. We, together with Norman, believe that designer can and should establish a link between technology and consumer (Norman 2009).

Another key principle, which we have to take into account, studying the design process is the cost of the product. «*Design is tied to mass production and availability, and this is often the most difficult challenge for designers. Create a good seat at the cost of 2,000 pounds lighter than create a good seat at a price of 20 pounds»* (Sudjic 2009, 122).

In conclusion, we would like to clarify the role of designer for modern society. Designer must analyze the past, predict the future and be responsible for the product of his (her) activity. «*All design is education of a sort. It may be education by studying or teaching at a school or university, or it may be education through design. In the latter case the designer attempts to educate his manufacturer-client and the people at the marketplace»* (Papanek 1984, 53)**.** Thus, the designer is the teacher. However, he (her) is not a strict mentor. Designer is leading participant in the concept of co-design (Sanders 2006).

In this way, «*design is a reflection of our economic systems, showing the imprint technology with which we have to work. This kind of language, and this is a manifestation of emotional and cultural values»* (Sudjic 2009, 34). Given the fact that it is a language, it is important to build a dialogue with the user. Only if there is a feedback we can talk about good design. That is why before working, the designer must define with several fundamental issues, namely:

- ***Who do I think are (or will be) the users of the product of my design?***
- ***What have I learned about these users' wants and needs?***
- ***Which do I think are these users' preferences with respect to their wants and needs, and why?***
- ***What system have I therefore designed for these users, and how can or should they use it?***
- ***What is my design vision?*** (Souza 2004, 149)

In the design process, it is necessary to consider a number of aspects, such as technology, product cost, etc., but the most important thing is to realize for whom you work, to know your user perfectly.

Finally, designer is a conductor in the process of co-creation and co-design.

REFERENCES

Brainstorming. 2015. http://www.mindtools.com/brainstm.html (accessed April 15, 2015).

Buchanan, Richard. *"The Convergence of Management and Design" by Richard Buchanan, Ph.D.* . 9 April 2010. https://www.youtube.com/watch?v=xpKJSvKrk7o (accessed April 10, 2015).

—. *Discovering Design: Explorations in Design Studies* . Chicago: University Of Chicago Press, 1995.

—. "Richard Buchanan: Keynote." *Vimeo.* 25 February 2011. https://vimeo.com/20379481 (accessed April 10, 2015).

Carnegie Mellon's School of Design. n.d. http://design.cmu.edu/ (accessed April 15, 2015).

Design Department at The Ohio State University. 2015. http://design.osu.edu/front (accessed May 15, 2015).

Interaction Design Association. 2009. https://vimeo.com/ixdaglobal (accessed April 25, 2015).

Norman, Donald A. *The Design of Everyday Things.* London/New York: MIT Press, 2000.

—. *The Design of Future Things.* 2009.

Osborn, Alex. *Applied Imagination.* 1953.

Papanek, Victor J. *Design for the Real World: Human Ecology and Social Change.* Chicago: Academy Chicago Publishers, 1984.

Product Design Hub. Industrial designers community and resources. б.д. http://productdesignhub.com/ (дата обращения: 17 April 2015 г.).

Sanders, Elizabeth. "Design Serving People." *Cumulus Working Papers.* Copenhagen: Publication Series G University of Art and Design Helsink, 2006. 28-33.

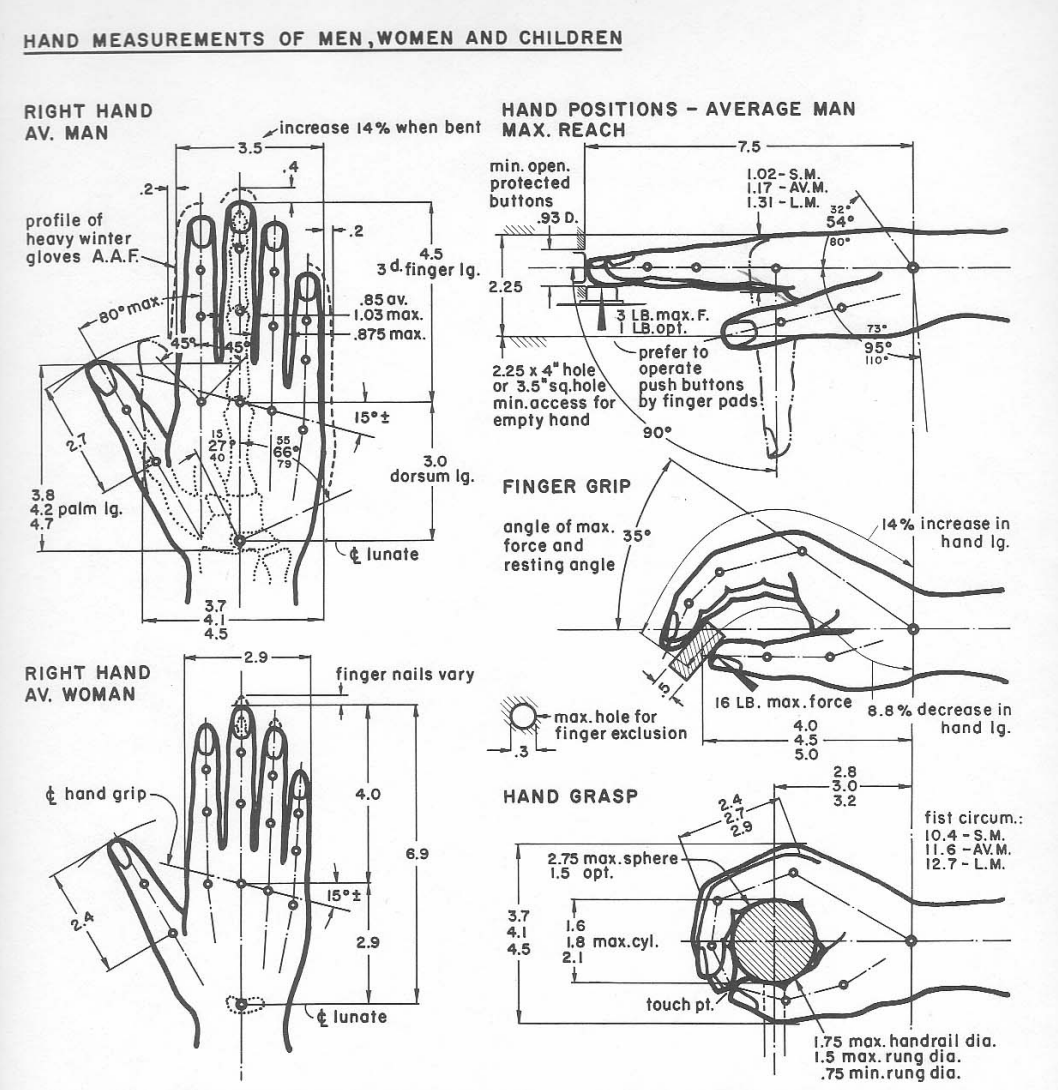
Souza, Clarisse Sieckenius de. *The Semiotic Engineering of Human-Computer Interaction.* 2004.

Sudjic, Deyan. *The Language of Things: Understanding the World of Desirable Objects* . W. W. Norton & Company, 2009.

Takahashi, Shimpei. *Play this game to come up with original ideas.* May 2013. http://www.ted.com/talks/shimpei_takahashi_play_this_game_to_come_up_with_original_ideas#t-1003 (accessed May 15, 2015).

ERGONOMICS

By definition of the International Ergonomics Association, «*Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system*» (IEA 2015). Other elements of the system involve place, tool, product, technical processes, service, software, environment, as well as other humans. Ergonomics «*seeks to improve performance and well-being through systems*» (Jan Dul 2012, 4). Performance includes productivity, efficiency, effectiveness, quality, innovativeness, flexibility, safety and security, reliability, sustainability. Well-being has to do health and safety, satisfaction, pleasure, learning, personal development.



HAND DATA	MEN			WOMEN			CHILDREN			
	2.5% tile	50.% tile	97.5% tile	2.5% tile	50.% tile	97.5% tile	6 yr.	8 yr.	11 yr.	14 yr.
hand length	6.8	7.5	8.2	6.2	6.9	7.5	5.1	5.6	6.3	7.0
hand breadth	3.2	3.5	3.8	2.6	2.9	3.1	2.3	2.5	2.8	—
3d. finger lg.	4.0	4.5	5.0	3.6	4.0	4.4	2.9	3.2	3.5	4.0
dorsum lg.	2.8	3.0	3.2	2.6	2.9	3.1	2.2	2.4	2.8	3.0
thumb length	2.4	2.7	3.0	2.2	2.4	2.6	1.8	2.0	2.2	2.4

Figure 3 - Hand measurements of men, women, and children (Dreyfuss 1960)

There are several types of ergonomics: physical ergonomics, cognitive ergonomics and organizational ergonomics. Physical ergonomics takes into account human anatomical and anthropometric. «*Cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans*» (IEA 2015).Finally, organizational ergonomics optimizes «*sociotechnical systems, including their organizational structures, policies, and processes*». (IEA 2015)

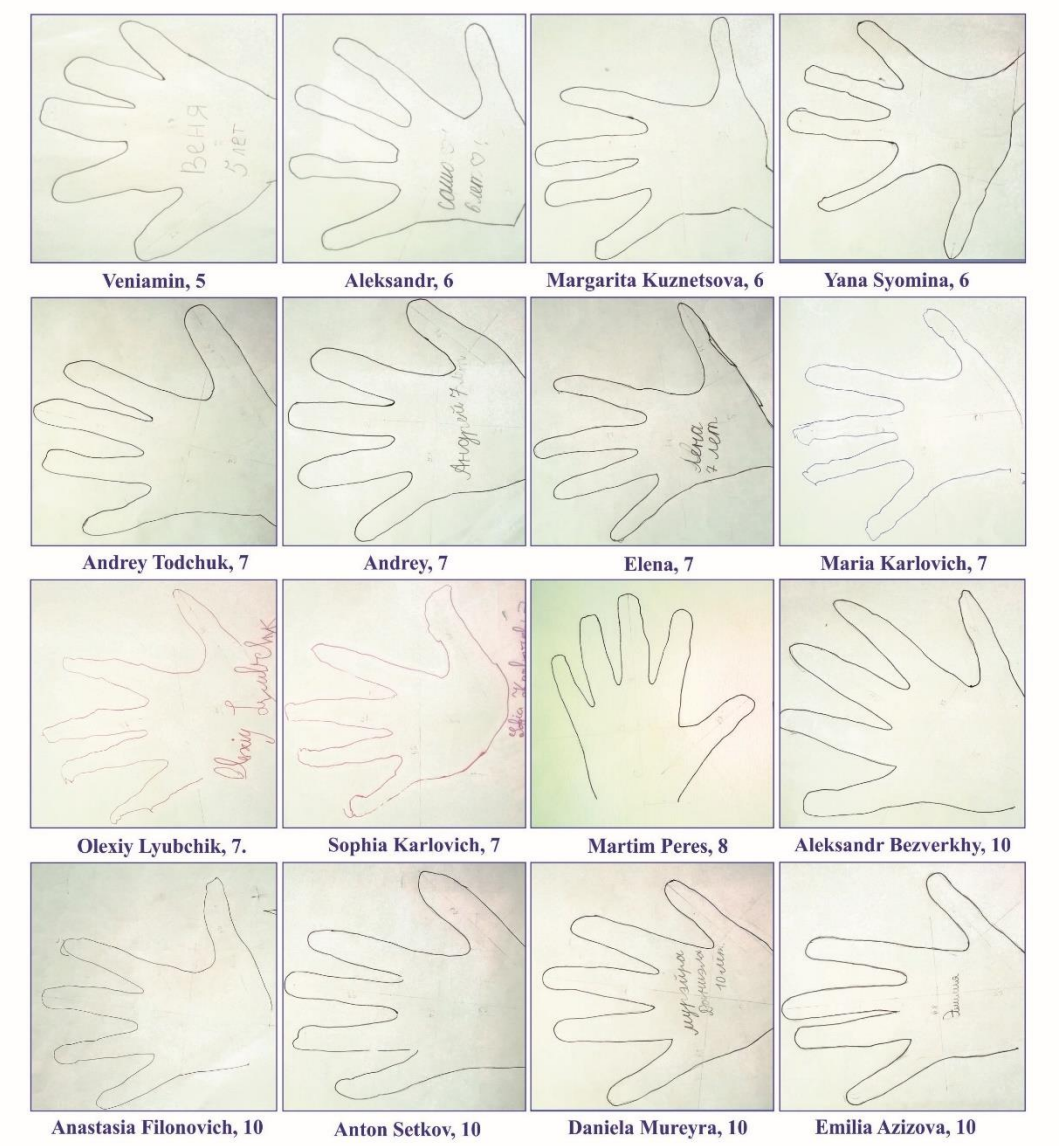


Figure 4 - Palms of experts (N. Lygina, 15.04.2015)

Within the physical ergonomics, we will look primarily at the hands, because children use them during play with educational toys. Currently, many developments study hands. In our work, we will focus on data collected by Henry Dreyfuss, an ancestor of user–centred design. (Dreyfuss 1960). However, the study of the literature shows that for optimal indicators, we need to gather more information within a narrow group (for example, *«Egyptian children aged 3-6 years»* (Amaal Hm Ebrahim 2014) or «*children aged between*

six and 19 years, from a city located in the northeast of São Paulo state» (Ferreira, et al. 2011) and so on). We found it useful to check the ergonomic characteristics of our experts.

To do this, we asked children to outline their palm. We made some measurements and organized data.

Table 1 - Hand data of experts

HAND DATA	Hand length, mm	Hand breadth, mm	3d finger lg., mm	Dorsum lg., mm	Thumb length, mm
Veniamin, 5	114	68	67	47	37
Aleksandr, 6	127	58	80	47	44
Margarita Kuznetsova, 6	134	64	82	52	51
Yana Syomina, 6	120	60	70	50	45
Andrey Todchuk, 7	161	70	97	64	55
Andrey, 7	147	77	90	57	47
Elena, 7	147	64	87	60	55
Maria Karlovich, 7	115	56	68	47	34
Olexiy Lyubchik, 7.	131	63	83	48	44
Sophia Karlovich, 7	115	56	70	45	42
Martim Peres, 8	141	67	91	50	47
Aleksandr Bezverkhy, 10	166	86	102	64	60
Anastasia Filonovich, 10	146	66	95	51	47
Anton Setkov, 10	166	78	98	68	57
Daniela Mureyra, 10	150	68	100	50	47
Emilia Azizova, 10	160	68	95	65	48
Maksim Melnichuk, 10	182	68	112	70	59

Within the framework of cognitive ergonomics, psychologists, based on the basic abilities of children of a certain age, have developed a set of children's preferences. For example, age of 5-6 years is a phase of intensive mental development. «*At this age occur progressive changes in all spheres ranging from the improvement of the psycho-physiological functions and ending with the appearance of complex personal tumors»* (Psychological peculiarities of children of 5-6 years 2013). However, children of this age do not share the real world and fantasy. They invent different situations and characters for themselves and their peers that is why drama and pretend play are at their zenith. These children have a good general and and fine-motor skills. It allows them to ride a bike, run, climb. Children can cut with scissors, paste, trace, draw, and color, in addition, they able to use a computer keyboard.

At the age of 7-8 years, children tend to gain knowledge. People of this age have a good concentration of attention; their thoughts may be based on the logic. Additionally

children of 7-8 years actively use reflective thinking. As for physical activity, children of this age are «*much stronger, have greater endurance, and are ready for more challenges».* (Therrell 2002, 19). They are often interested in games requiring great dexterity, «*such as complex hand games, jacks, snapping fingers, tying a bow, constructing models, operating hand puppets, needlepoint, sewing, weaving, and braiding»* (Therrell 2002, 20).

If we talk about age characteristics of children of 9-10 years, we need to note that emotions play an important role in the psyche of this age. Children of this age are very friendly; however, evaluation of adults and peers is very important for them at this time. As for physical activity, the children «*continue to develop their skills at many of the sports, games, and activities from their early elementary years»* (Therrell 2002, 20). Instead of finished products, they often prefer raw materials for creating their own unique products. They prefer processes that are more complex, such as woodworking, making pottery, staging plays, advanced science projects, and generating computer graphics. «*They are beginning a stage where they seek to clarify and express more complex concepts, moving from the concrete to the abstract and applying general principles to the particular*» (Therrell 2002, 20)

Based on the above, experts have developed a number of activities to optimize sociotechnical systems. The purpose of such actions is to protect the public «*against unreasonable risks of injury and death associated with consumer products»* (Therrell 2002, 1). For example, Council Directive concerning the safety of toys (Council Directive 88/378/EEC of 3 May 1988 on the approximation of the laws of the Member States concerning the safety of toys 1988) identifies the basic provisions that toys of the European Union must match. *«Toys may be placed on the market only if they do not jeopardize the safety and/or health of users or third parties when they are used as intended or in a foreseeable way, bearing in mind the normal behaviour of children. In the condition in which it is placed on the market, taking account of the period of foreseeable and normal use, a toy must meet the safety and health conditions laid down in this Directive».* (Council Directive 88/378/EEC of 3 May 1988 on the approximation of the laws of the Member States concerning the safety of toys 1988, 27).

This Directive takes into account physical properties «*Toys and their parts and, in the case of fixed toys, their anchorages, must have the requisite mechanical strength and, where appropriate, stability to withstand the stresses to which they are subjected during use without breaking or becoming liable to distortion at the risk of causing physical injury*» (Council Directive 88/378/EEC of 3 May 1988 on the approximation of the laws of the Member States concerning the safety of toys 1988, 42). Mechanical characteristics are also important. «*Toys and their parts and, in the case of fixed toys, their anchorages, must have the requisite mechanical strength and, where appropriate, stability to withstand the*

stresses to which they are subjected during use without breaking or becoming liable to distortion at the risk of causing physical injury» (Council Directive 88/378/EEC of 3 May 1988 on the approximation of the laws of the Member States concerning the safety of toys 1988, 42). According to this document, safety is the most important aspect. «*Toys must be so designed and constructed that the risks of physical injury from contact with them are reduced as far as possible»* (Council Directive 88/378/EEC of 3 May 1988 on the approximation of the laws of the Member States concerning the safety of toys 1988, 42). Toys should be age-appropriate. Besides that, «*Labels on toys and/or their packaging and the instructions for use which accompany them must draw the attention of users or their supervisors fully and effectively to the risks involved in using them and to the ways of avoiding such risks»* (Council Directive 88/378/EEC of 3 May 1988 on the approximation of the laws of the Member States concerning the safety of toys 1988, 45)

Consumer Product Safety Act (The Consumer Product Safety Improvement Act (CPSIA) 2013) takes as its basis the Small Parts Regulation, age characteristics and preferences as well as play behavior. This document is a recommendation; it serves as the primary structure for the guidelines. We have taken blocks and connecting materials for reference. In The Application «AGE DETERMINATION GUIDELINES» (Therrell 2002) there are data for children from three to twelve years.

As we see ergonomics is very important part for designer. It should be an integral part of the design process. In addition, the experts should be active participants of this action. Only in this case it is possible to obtain optimum result.

REFERENCES

Amaal Hm Ebrahim, Sm Reda. "Normative Data of Handgrip Strength and Hand Dexterity of Preschool Egyptian Children Aged 3-6 Years." *Physiotherapy*, 2014: 1-14.

"Council Directive 88/378/EEC of 3 May 1988 on the approximation of the laws of the Member States concerning the safety of toys." *European Union law.* 3 May 1988. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31988L0378 (accessed April 20, 2015).

Dictionary, American Heritage. *The American Heritage Dictionary of the English Language, 5th edition.* Houghton Mifflin, 2012.

Dreyfuss, Henry. *The Measure of Man; Human Factors in Design.* 1960.

Ferreira, Andréa Campos de Carvalho, Antonio Carlos Shimano, Nilton Mazzer, Cláudio Henrique Barbieri, Valéria Meirelles Carril Elui, and Marisa de Cássia Registro Fonseca. "Grip and pinch strength in healthy children and adolescents." *Acta Ortopédica Brasileira*, Mar./Apr. 2011: vol.19 no.2.

IEA. 2015. http://www.iea.cc/whats/index.html (accessed April 12, 2015).

Jan Dul, Ralph Bruder, Peter Buckle, Pascale Carayon, Pierre Falzon,William S. Marras, John R. Wilson and Bas van der Doelen. "A strategy for human factors/ergonomics: developing the discipline and profession." *Ergonomics*, 2012: 1-27.

Martin, Elizabeth A. *Concise Medical Dictionary.* Oxford University Press, 2010.

Millodot, Michel. *Dictionary of Optometry and Visual Science, 7th edition.* Melbourne : ANTHEA COCHRANE , Department of Optometry and Vision Sciences, The University of Melbourne , 2008.

Mosby's Dental Dictionary, 2nd Edition. 2008.

Mosby's Medical Dictionary, 8th edition. Mosby, 2009.

O'Toole, Miller-Keane and Marie T. *Miller-Keane Encyclopedia & Dictionary of Medicine, Nursing & Allied Health -- Revised Reprint, 7th Edition.* Camden, New Jersey: Saunders, 2005.

"Psychological peculiarities of children of 5-6 years." *Human psychology.* 02 December 2013. http://en.psibook.com/posts/psychological-peculiarities-of-children-of-5-6-years.html (accessed April 15, 2015).

"The Consumer Product Safety Improvement Act (CPSIA) ." *Consumer Products Safety Commission.* 06 December 2013. http://www.cpsc.gov/en/Regulations-Laws--Standards/Statutes/The-Consumer-Product-Safety-Improvement-Act/ (accessed April 20, 2015).

Therrell, James A. *AGE DETERMINATION GUIDELINES: Relating Children's Ages To Toy Characteristics and Play Behavior*. 2002.

EDUCATION

Education is one of the major issues in our work As we know, education is a set of knowledge that a person receives in the learning process, «*it is part of the culture and is intended to generate a series of habits (social, cognitive, intellectual, emotional, behavioral, communication and so on)»* (Vakurov 2013). In its turn, learning is the process of acquiring tools and parents, mentors, teachers, designers can provide the necessary tools. To provide children with the necessary tools, we need to understand what learning process is.

As we know, learning is not a specialized realm of human functioning such as cognition or perception. It involves the whole personality. Learning is thinking, feeling, perceiving and behaving. «*It is the major process of human adaptation. This concept is much broader than that commonly associated with the school classroom. It occurs in all human settings, from schools to the workplace, from the research laboratory to the management boardroom, in personal relationships and the aisles of the local grocery. It encompasses all life stages, from childhood to adolescence, to middle and old age. Therefore it encompasses other, more limited adaptive concepts such as creativity, problem solving, decision making, and attitude change that focus heavily on one or another of the basic concepts of adaptation. Learning can be understood as a process where knowledge is created through the transformation of experience. It can be fruitful to think of the learner – from a very early age – as a 'scientist', actively searching for meaning in experience… Learners need to be able to reflect upon their own abilities, be aware of their own competences, and work out the best ways to learn new things (the skill). They need the motivation that comes from new experiences and new ways to exchange ideas (the will). Lastly, learning should be enjoyable and rewarding (the thrill)»* (The future of learning 2013, 4).

In this connection in recent years, the role of the mentor was changed. As a rule, mentor is an adult, spreading knowledge. Mentor ceases to be an instructor. He (her) becomes a co-participant. The task of a mentor - co-participant is not to force children to gain knowledge, but to involve them into the learning process, to arouse their interest. Mentor - co-participant explains and simplifies the task, if necessary, observes how the child copes with the task and withdraws support when the child can proceed independently. Such role of mentor - co-participant is more valuable because «*people learn by doing: testing out new things, and reflecting upon the result. This learning is enhanced through communication and exchange, and participation with others. Knowledge is built when people connect their own sense of discovery and fascination with a meaningful learning process, and a sense of purpose in a larger community»* (The future of learning 2013, 78).

Not only role of mentor is transformed, but also the process of learning is undergoing significant changes. Not didactics is paramount, but play.

The concept of the play and its role in people's lives is described in detail in the treatise «Homo Ludens» by Johan Huizinga (Huizinga 1980). In his book, Huizinga argues that the play is older than culture, because we can see it at animals. Play is a serious and frivolous at the same time. According to Huizinga, has no coercion, but has a strict internal order. Despite the fact that playing is more common for children, it covers almost all spheres of our life.

Philippe Rochat, Professor of Psychology and Director of the Emory Infant and Child Laboratory at the Emory University in Atlanta, GA, USA, highlights five fundamental characteristics of play activities: «*freedom(no obligation); separation(circumscribed in time and space); non-productive orientation (not geared toward a specific production of goods); rules(includes conventions regarding the suspension of reality); and finally is fictitiousness(entails an awareness of a reality that is different from ordinary life)»* (Rochat 2012)

David Gauntlett and Bo Stjerne Thomsen argue, «*playing is strongly associated with making… When making things, whether playful scenarios or cardboard spaceships, children are at the same time 'engaging in the serious business of building the cognitive platform for their future skills… Indeed, making can be a process which 'grounds' a person in the world as an active participant».* (Gauntlett D., Thomsen B. S. 2015, 20)**.** We and David Whitebread (Whitebread 2012) believe that the playing is one of the greatest achievements of humanity together with the language, culture and technology. All these achievements would be possible only with play. According to the researchers, play is a heart of emotional wellbeing and mental health.

«Play is the most effective and inspiring way for children to acquire the skills needed to create new possibilities and meet the many challenges of the future. For both children and adults, play is one of our favourite ways of learning. Play enables us to explore, practice and try out ways of tackling similar challenges in the real world. Playing involves a constant process of 'try, fail and try again' – helping us develop and fine-tune our creative and critical thinking skills. Play has a key role in establishing the vital early learning skills that underpin all other learning throughout our lives». (LEGO Foundation. Introduction 2013, 3)**.** Play helps children develop intellectual, emotional, social and creative skills. It helps them during all their life. That is why we can put an equal sign between play and learning.

«When children learn through play, they are personally motivated by the satisfaction of being embedded in the activity, at their level of challenge and interest. This means children are joyful, actively engaged with their bodies and minds, taking risks and

experimenting, to come up with ideas and questions, creating things and solving problems. A quality learning through play experience requires the integration of both cognitive and emotional skills, by providing opportunities to set own goals, maintain focus and problem-solve, at the same time as reflecting on impact, being passionate and acting flexibly when circumstances change» (Learning through Play 2015)

As we can see, skills like problem-solving, creativity empathy, communication and teamwork have their foundations in play.

Based on the above educational model will also change. Creativity is becoming the most popular skill in today's world. «*To sustain the creative mindset, within any culture, we need a 'lifelong kindergarten' spirit, characterised by as many opportunities as possible for playing, making and sharing. This must involve stimulating environments, and support from leaders, role models, and peers»***.** (Gauntlett D., Thomsen B. S. 2015, 7)**.** Therefore, for maximum results, we need to rethink the concept of play and to revise our education system. «*When we say 're-defining play' we mean that we want to change the way that people understand the importance of play – especially the huge value it has in helping children to learn essential skills for life in the 21st century. When we say re-imagining learning' we mean that we want to help parents and education systems use the transformative power of play to improve learning for millions of children»* (LEGO Foundation. Introduction 2013, 5)**.**

Participants of Lego foundation presented their vision of the future of learning. They consider the main aspects of learning - 'skill', 'will' and 'thrill'. «*Learners need to be able to reflect upon their own abilities, be aware of their own competences, and work out the best ways to learn new things (the skill). They need the motivation that comes from new experiences and new ways to exchange ideas (the will). Lastly, learning should be enjoyable and rewarding (the thrill)»* (The future of learning 2013, 4).

Learning is a kind of system, which grows from the individuality of learners, by dint of their experience and relationships, to the broader context.

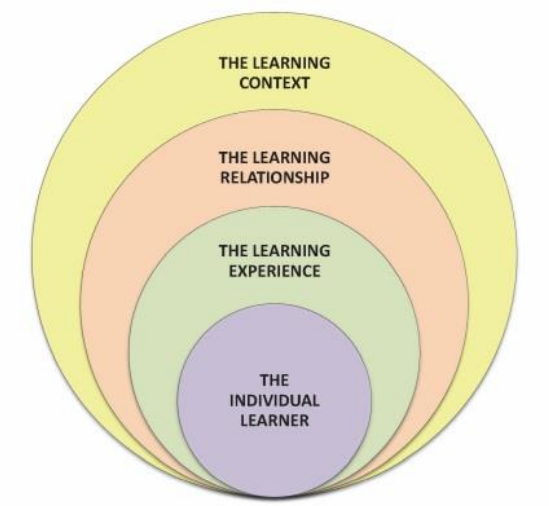


Figure 5 - Lego foundation levels of learning (The future of learning 2013, 3)

Participants of Lego foundation release three types of creativity - combination, exploration and transformation that are critical components in learning. Based on three types of creativity it is possible to formulate three stages for learning.

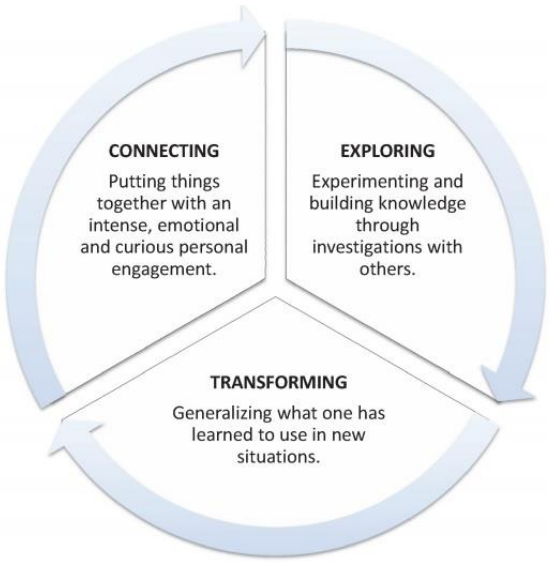


Figure 6 - Lego foundation learning system (The future of learning 2013, 81)

«Connecting. This is the journey of intensified, heightened curiosity and wonder, where personal interests and emotional engagement serve as the starting point for learning. It is fulfilled by combining personal skills and motivation, making connections between things and ideas, and posing questions to existing conditions.

Exploring. This involves the investigation of data and exploring the questions and phenomena found in the connecting stage. It includes experimentation, problem-solving, trying out new things and testing out ideas with a focus on detailed observations of cause and effect.

Transforming. This involves recognising opportunities where existing knowledge is relevant, and the creative process of applying it in a new situation. This happens by generalising what one has learned, adding perspectives from others and making use of a diverse network» (The future of learning 2013, 81)

Thus, the attitude of all components of learning process is possible to represent as follows:

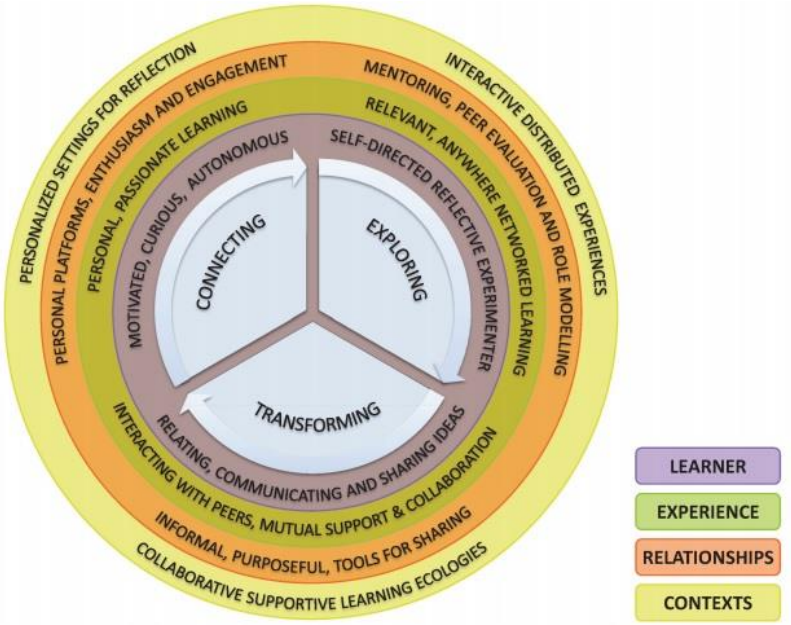


Figure 7 - Lego foundation full model for the Future of Learning (The future of learning 2013, 86)

Participants of Lego foundation noted that individual skills of learning are definitely important, but it is also necessary to have relationships with other individuals and entities, with the environment and the media. «*Despite the importance of individual orientations to knowledge, learning is, crucially, a social process. Today, this means not just face-to-face learning, but also using online networks – and finding valuable ways to connect the two. Through the internet we can connect with people who share our passions, and who are often willing to share knowledge and support other learners. Free online learning resources and communities have revolutionized the learning possibilities for many people by enabling connections to resources, people, and tools»* (The future of learning 2013, 5)**.**

Thus, learning is process that occurs from childhood to middle and old age. Such concepts as creativity, problem solving, decision making come to the fore in contemporary education. Not didactics is paramount, but play. Play is a serious and frivolous at the same time. In addition, it covers almost all spheres of our life. We can develop the basic concepts of modern education, especially creativity through play. Personal skills are important in the learning process, but also it is necessary to have a connection with others and the world. Mentor - co-participant should be a key assistant in the process of learning.

REFERENCES

Education. 10 January 2015. http://www.scientificamerican.com/education/ (accessed December 15, 2014).

Gauntlett D., Thomsen B. S. “CULTURES OF CREATIVITY.” *legofoundation.* 2015. http://www.legofoundation.com/en-us/research-and-learning/foundation-research/cultures-of-creativity (accessed April 20, 2015).

Huizinga, J. *Homo Ludens. A Study of the Play Element in Culture.* London: ROUTLEDGE & KEGAN PAUL, 1980.

“Learning through Play.” *legofoundation.com.* 2015. http://www.legofoundation.com/en-us/who-we-are/learning-through-play (accessed April 15, 2015).

«LEGO Foundation. Introduction.» *legofoundation.com.* 2013. http://www.legofoundation.com (дата обращения: 18 April 2015 г.).

Osborn, Alex. *Applied Imagination.* 1953.

Rochat, Philippe. *The meaning of play in relation to creativity.* 2012.

“The future of learning.” *The LEGO® Learning Institute.* 2013. http://www.legofoundation.com (accessed April 25, 2015).

Vakurov, Alexander. *The difference between education and training.* 13 June 2013. http://vakurov.ru/site/index.php?id=1799&Itemid=51&option=com_content&task=view (accessed April 20, 2015).

Whitebread, David. *The importance of play.* A report on the value of children’s play with a series of policy recommendations, Cambridge: University of Cambridge, 2012.

SCIENCE FOR CHILDREN

What is a comet? Why the sky is blue? How many senses in humans? What is a star? Studying the world, children ask many questions from physics, biology, chemistry, geography and so on. Sometimes it is quite difficult to answer such questions without scientific expertise. Even if you have some knowledge, the question is how to explain this material to children in an accessible and understandable form. To do this we can use play activity, because it has a possibility to make science fun and engaging for children, can put the important concepts into the form that children can understand and enjoy.

In the opinion of Rene Smith, the creator of the Science Kids website, «*inspiring an interest in science at a young age can help kids grow up with the tools needed to form questions about the world around them and make decisions based on their own reasoning. Fun activities, facts, projects and experiments can be the first step in fostering a desire amongst kids to learn more about science and technology, subjects that have practical applications in both careers and everyday life»*. (R. Smith 2015)

Children are ready to acquire scientific knowledge, moreover they are able to adapt and transform it. Many famous inventions were done by young people due to they have received theoretical scientific knowledge and knowledge gained empirically. For example, 14-year-old child came up the electronic television in 1920.

A boy named Louis Braille when he was 12 years old, thought up raised letters font for blind people. Now this famous language system helps blind people to read and write.

John Conteh 14 year old created the device for the hearing-impaired people. Thanks to this invention, the deaf people can feel the music. «*The operating principle of Good Vibration based on the transformation of tactile sensations into sound»***.** (Myhailyuta 2014) The idea came to Conteh in an original way: he touched a guitar with his teeth and realized that it is possible to transform tactile relationship into sound.

A teenager from New York developed wearable sensors for people suffering from Alzheimer's. These sensors send mobile alerts when «*a dementia patient begins to wander away from bed. His invention uses coin-sized wireless sensors that are worn on the feet of a potential wanderer. The sensors detect pressure caused when the person stands up, triggering an audible alert on a caregiver's smartphone using an app»***.** (Murano 2014)

Jack Andraka created a pancreatic cancer detection tool. Param Jaggi offered device to reduce pollution coming from his car and Boyan Slat claimed that his invention would save the world's oceans. There are many other examples.

Currently, scientists and designers offer many tools for children and their parents to learn more about the amazing world of science. For example, online portals (**http://www.sciencekids.co.nz/**, **http://kids.usa.gov**, **http://www.experimentanium.ru**)

have a lot of fun science experiments, cool facts, online games, free activities, ideas, lesson plans, photos, quizzes, videos & science fair projects. Experts organized various scientific children's association, for example, British Science Association develops a program called Children's University and CREST. Children's University offers exciting and innovative learning activities to children from five to fourteen outside normal school hours. CREST may be the result of such activities. «*CREST Star is a UK-wide award scheme enabling children, usually aged 5 - 11, to solve science, technology, engineering, and maths (STEM) problems through practical investigation».* (CREST Awards 2015)

There are many projects, such as «Scientists for Children». American Chemical Society has developed a site for children called Adventures in Chemistry (**http://www.acs.org**). We can find here a lot of interesting experiments, games and fun facts about chemistry.

At the Faculty of Architecture of the University of Lisbon it was recently established the office FAjúnior for «*dissemination of programs and projects interaction with the younger sections of the population and the institutions where they study»* (Creation of the Office FAjúnior 2015).

Experts offer numerous workshops and master classes, for example, Ciência Divertida (RIOSULSHOPPING)

Figure 8 RIOSULSHOPPING (N. Lygina, 14.04.2014)

In addition, there are a lot of books, cartoons and educational games.

At present time, science for children is one of the social initiatives all over the world.

Funding in this area is supported by the Project Sustainable Europe, with European Commission initiative, promoted by the European Information Centre Jacques Delors, as the Intermediate Body Frame Management Partnership established between the Portuguese Government and the European Commission. In addition, there are a number of programs in this area. For Example, Science Learning+, The National Science Foundation (NSF), Science House Foundation and many others.

Science Learning+ is an international initiative that aims to understand the power of informal learning experiences inside and outside of school. Science Learning+ established in partnership with the US-based National Science Foundation and the UK-based Economic and Social Research Council, and in collaboration with the Gordon and Betty Moore Foundation, the MacArthur Foundation and the Noyce Foundation.

The National Science Foundation (NSF) is an independent federal agency created "to promote the progress of science; to advance the national health, prosperity, and welfare". With an annual budget of $7.2 billion (FY 2014), they are the funding source for approximately 24 percent of all federally supported basic research conducted by America's colleges and universities.

House Foundation is an international New York City-based NGO (501(c)3 charity) The Foundation supports educational organizations, runs global educational programs for schools, connects global network of scientists with schools and students, produces educational media, awards scholarships and prizes for outstanding students, and recognizes teachers for their contribution to science and math education.

Therefore, interest in science at a young age gives children the opportunity to develop tools necessary for everyday life. That is why "Science for Children" is one of the social initiatives now. For the development of this area, experts have created many resources (sites, programs, awards). Funding for this area is carried out at the state level.

REFERENCES

Chemistry for Life. 2015. http://www.acs.org/content/acs/en.html (accessed December 26, 2014).

Creation of the Office FAjúnior. 02 February 2015. http://www.fa.ulisboa.pt/index.php?option=com_content&view=article&id=2584%3Agabinete-fajunior&catid=212%3Apress-release&Itemid=380&lang=pt (accessed December 26, 2014).

CREST Awards. 15 January 2015. http://www.britishscienceassociation.org/crest-awards/childrens-university-and-crest (accessed December 26, 2014).

Education. 10 January 2015. http://www.scientificamerican.com/education/ (accessed December 15, 2014).

Experimentanium. 15 January 2015. http://www.experimentanium.ru/ (accessed December 26, 2014).

Fixiki. 2011. http://fixiki.ru/ (accessed December 20, 2014).

Hodgkin, Deb. *Young Scientists. Doing Science with Babies, Toddlers and Kids - A Book for Parents.* Deborah Hodgkin, 2010.

Kids.gov, official web portal for kids. 02 February 2015. http://kids.usa.gov/social-studies/index.shtml (accessed December 26, 2014).

Kiss, Albert. *Albert Kiss. Scientific Children's Association in primary schools.* Zalabér, 2011.

Murano, Grace. *10 Amazing Inventions by Teens.* 24 August 2014. http://www.oddee.com/item_99064.aspx (accessed December 25, 2014).

Myhailyuta, Gennadiy. *Inventions made by children.* 09 May 2014. http://ogend.ru/nu/izobreteniya-sdelannye-detmi.html (accessed December 25, 2014).

National Science Foundation. n.d. http://www.nsf.gov/ (accessed December 25, 2014).

Science for Kids. 06 February 2015. http://www.sciencekids.co.nz/ (accessed December 20, 2014).

Science House Foundation. 2010. http://sciencehousefoundation.org/ (accessed December 26, 2014).

Science Learning. Funding schemes. 2015. http://www.wellcome.ac.uk/Funding/Public-engagement/Funding-schemes/Science-Learning/index.htm (accessed December 25, 2014).

Science4you . 2014. http://www.science4youtoys.co.uk/about-us/company (accessed December 26, 2014).

SIX is social innovation. 2015. http://www.socialinnovationexchange.org/about#about (accessed December 20, 2014).

Smith, Rene. *About Science Kids.* February 2015. http://www.sciencekids.co.nz/about.html (accessed December 14, 2014).

The Young Foundation. 2015. http://youngfoundation.org/ (accessed December 26, 2014).

MARKET

Scientific toys are the most simple and interesting way to involve children into science, to show them what science is. It is understandable that these toys are increasingly appear on the toy market.

Clementoni is a consolidated leader in the world of educational games. Founded in 1963 by Mario Clementoni at present time this brand is synonymous of creativity, passion and attention to quality. The company is specialized on creation of innovative games. Therefore, in 1967 Superkid appeared, it was the first electronic educational game and a true revolution in interactive learning. Clementoni creates games for all age groups. It has an extraordinarily rich assortment. The games are translated in 16 different languages and distributed in 56 countries. Clementoni has a passion to research and innovation. All games and technologies are developed with the assistance and advice of experts, technicians, psychologists and educationalists from all over the world. By Mario Clementoni conviction, «*Play is a serious thing. We should never stop playing, especially when we grow up»* (THE MAN OF GAMES 2015)

Figure 9 - Interactive Quiz Puzzle MINNIE (from: http://www.clementoni.com/en/product/interactive-quiz-puzzle-minnie/, 26.12.2014)

Scientific Toys is another company specializing in the design and manufacture of electronic products, known for their originality, quality and cost. People use their products all over the world. The most popular toys are wireless remote control vehicles, planes, amphibious vehicles, submarines, wireless surveillance units, electronic learning aids in different languages with various themes and difficulty levels and musical products with original compositions from the professionals. This company invests in the latest software,

hardware and staff training to ensure that their product development and engineering teams have the best resources behind them.

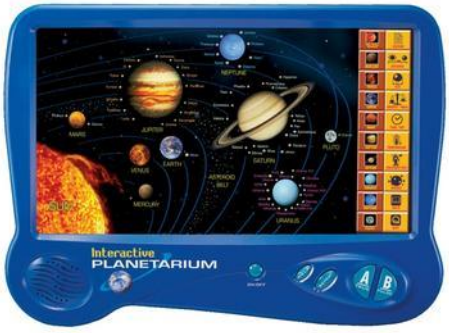


Figure 10 - Interactive Planetarium (from: http://www.scientific.com.hk/product_detail.php?pid=9, 26.12.2014)

The scientific toys affect all areas of science and use the latest scientific developments and trends. For example, Inspiring Toys specialize in educational battery-free toys. Green Toys Inc. makes an awesome line of classic children's toys constructed from recycled plastic and other environmentally friendly materials. It helps to reduce fossil fuel use and greenhouse gas emissions, as well as to improve the overall health and happiness of the planet.

TEDCO was a research & development company but eventually became entirely dedicated to toys and achieved considerable success in this. This company specializes in the development of scientific and educational toys like the TEDCO Gyroscope. They are focused on creativity, education and fun pastime.

Figure 11 - Original TEDCO Gyroscope (from: http://www.tedcotoys.com/p/original-tedco-gyroscope-nostalgic-pak, 26.12.2014)

Make science fun is the motto of Steve Spangler, teacher, science, toy designer and a television personality. He is the founder of SteveSpanglerScience.com, a Denver-based company specializing in the creation of science toys, classroom science demonstrations and teacher resources. Spangler and his design team have developed more than 140 educational toys.

Figure 12 - Geyser Rocket Car (from: http://www.stevespanglerscience.com/collections/best-sellers/geyser-rocket-car.html, 26.12.2014)

Edu-Science Limited is a designer, developer, manufacturer and marketer of educational and experimental toys products with headquartered in Hong Kong. Binoculars and telescope were the first toys of Edu-Science but soon the company has evolved into an integrated toy manufacturer with diverse design and manufacturing capabilities. Today Edu-Toys offers more than ten different scientific toy categories in more than one hundred countries. Edu-Science has wide range of products from optical items to experimental electronics kits, helping children explore the world from outer space to the land they live in. Their goal is to help children create a new world.

Figure 13 - Armored Car (from: http://www.edu-toys.com.hk/product.php?id=14, 26.12.2014)

Science4you develops, produces and markets scientific toys certified by the Faculty of Science, University of Lisbon. Their goal is «*to raise people's awareness for science and to show how it can be used in daily life, amongst children and society in general»*. (Science4you 2014). The company produces and sells scientific toys. This company also organizes various activities for children and their parents to show what a science is. "Aqui Há Ciência" is the first television program developed by Science4you for young scientists.

Figure 14 - Electric Challenge (from: http://www.science4you.pt/science/electric-challenge-detail, 26.12.2014)

Children are end-users of scientific toys, but it is necessary to remember about adults, because they make a decision to buy or not this or that toy. That is why manufacturers of toys, especially scientific, solve complex problems. Firstly, the toy must meet the requirements for safety, should develop, educate and enthral a child for some time. On the other hand, it should be fun and entertaining. Of course, the toy should to be non-expensive.

Summing up, we can note the following: toy market is fairly saturated, but only a few companies are engaged in scientific toys. "Make science fun" is one of the main mottos of manufacturers of scientific toys. Manufacturers of scientific toys are working closely with scientific institutes. The scientific toys affect all areas of science. The main consumer of scientific toy is a child but producers have to remember about the adults.

REFERENCES

Edu-Science (HK) Limited. 2013. http://www.edu-toys.com.hk (accessed December 26, 2014).

Fixiki. 2011. http://fixiki.ru/ (accessed December 20, 2014).

Geek Toys. 2015. http://www.thinkgeek.com/geektoys/science (accessed January 10, 2015).

Green Toys. 2015. http://www.greentoys.com/toys.html (accessed January 15, 2015).

Green Toys Recycled Plastic Cookware And Dining Set Review. 8 August 2014. http://www.thebrickcastle.com/2014/08/green-toys-recycled-plastic-cookware.html (accessed December 26, 2014).

Inspiringtoys. 2015. http://inspiringtoys.co.uk/4m-kidz-labs-green-science-eco-science-toys (accessed January 15, 2015).

Interactive Planetarium. 2007. http://www.scientific.com.hk/product_detail.php?pid=9 (accessed December 26, 2014).

labirint. 2015. http://www.labirint.ru/genres/2010/ (accessed December 20, 2015).

Science Museum. n.d. http://www.sciencemuseum.org.uk/online_science/apps.aspx (accessed January 10, 2015).

Science4you. 2014. http://www.science4youtoys.co.uk/about-us/company (accessed December 26, 2014).

Scientific Toys - Educational Science Toys. 2015. http://www.buzzle.com/articles/scientific-toys-educational-science-toys.html (accessed January 15, 2015).

Scientific Toys. 2007. http://www.scientific.com.hk (accessed December 26, 2014).

Steve Spangler Science. 2013. http://www.stevespanglerscience.com/ (accessed December 26, 2014).

Tedco Toys. 2015. http://www.tedcotoys.com/ (accessed December 26, 2014).

THE MAN OF GAMES. 2015. http://www.clementoni.com/en/the-man-of-games/ (accessed December 20, 2014).

Toys & Games. 2015. http://store.discovery.com/toys-games/index.php?v=discovery_tech-gadgets&nvbar=Toys+%26amp%3B+Games (accessed January 15, 2015).

Znatok. 2015. http://babadu.ru/store/vendor/znatok/ (accessed December 20, 2014).

TRENDS

First, we would like to define the meaning of the word «Trend». In our work, we will focus on the following definition: «*Trend is a general direction of change: a way of behaving, proceeding, etc. that is developing and becoming more common»***.** (Trend 2015)

Talking about trends it is appropriate to consider trends from several aspects: trends in materials, technology and toys directly. Because, as we know, technology is at the core of the contemporary world, «*but nothing will impact how things are made, and what they are capable of, more than the materials manufacturers use to make those things. New materials change both the manufacturing process and the end result»*. (Greenemeier 2013). Of course, the development of these aspects leads for the appearance of new trends in the world of toys. Consider these aspects in detail.

Technological trends.

World Economic Forum identified TOP 10 of innovative technologies in 2014:

- **Body-adapted Wearable Electronic** system is tiny and almost invisible device such as headphones that is able to monitor the status of the body and its vital organs.
- **Screenless Display** allows transmitting of visual information from a video source without the use of a screen.
- **Human Microbiome Therapeutics**. Intestinal microflora affects the development of many diseases. Currently, there are many clinical trials related to this issue. As a result, experts have found a group of microbes in a healthy gut. These microbes help create a new generation of drugs, and those in turn, will help to improve the treatment of human intestinal microflora. RNA-based Therapeutics - this is new generation of drugs.
- **Quantifed Self (Predictive Analytics)** are smartphones, which contain an incredible amount of information about the activities of people like the owners of these smartphones and their friends. It will help to build detailed predictive models about people and their behavior that should be a good purpose for urban planning, assignment of individual drugs, medical diagnostics.
- **Mining Metals from Desalination Brine**. Reduction of freshwater resources and the associated seawater desalination it is problem. Desalination can increase the supply of fresh water, but desalination need a lot of energy, and as a result, we obtain a waste of concentrated salt water. This waste can be considered as a source of raw materials are very valuable substances: lithium, magnesium, uranium, conventional soda, calcium, potassium compounds.
- **Grid-scale Electricity Storage**. All kinds of solid battery will also allow keeping sufficiently large amounts of energy in the cheap and available materials.

- **Nanowire Lithium-ion Batteries**. These batteries will soon conduct a full charge and produce 30-40% more electricity than today's lithium-ion batteries.
- **Brain – computer Interfaces**. You can control your computer just by thought.
- **Nanostructured Carbon Composites**. Increase in the operating efficiency of transport is one of the priority technology areas. Contribute to this will be the methods of Nano structuring of carbon fibre for advanced composite materials, which will help to reduce the weight of cars by 10% and more.

Figure 15 Screenless-Display (from: https://www.elprocus.com/introduction-to-screenless-displays-and-their-types/, 25.12.2014)

Trends in the field of materials.

Scientific American Magazine named TOP 10 of innovative materials 2014:

- **Bio - Inspired Plastic.** Light enough to permit flight and thin enough to accommodate flexibility and strong enough to protect its host, natural insect cuticle—found in the rigid exoskeletons of houseflies and grasshoppers—provides its host protection without adding weight or bulk. Researchers at Harvard University's Wyss Institute for Biologically Inspired Engineering have developed a new material called Shrilk to replicate insect cuticle's strength, durability and versatility. Shrilk—so called because it is composed of chitin commonly extracted from discarded shrimp shells and fibroin protein from silk—could be used to make trash bags, packaging and diapers that degrade quickly. As an exceptionally strong, biocompatible material, it might also be used to suture wounds that bear high loads, such as in hernia repair or as a scaffold for tissue regeneration.
- **Ultrathin Platinum**. Hydrogen fuel cell vehicles could provide clean transportation in the future, but they remain expensive in part because they use the precious metal platinum to facilitate the chemical reactions that produce electricity

within the cell. A new method for quickly depositing ultrathin layers of platinum might make it practical to reduce the amount of the metal used in fuel-cell catalysts, thereby lowering their cost significantly. Current methods for applying atom-thick layers of platinum—mainly, atomic layer deposition—are slow and complicated. The new approach is cheap and easy to implement, according to the National Institute of Standards and Technology. Essentially, platinum dissolved in a solution is deposited in single-atom-thick layers by alternately applying positive and negative voltages. Repetition can build layers of any desired atomic thickness.

- **Cheaper, Lighter Carbon Fiber**. Autos of the future will require strong, lightweight carbon-fiber composite structures to enhance efficiency and driving range, but low-cost fibers will be needed for market success. A consortium of national labs, industry and academia working at Oak Ridge National Laboratory's Carbon Fiber Technology Facility are working to overcome the challenges of making cheaper carbon fiber. The U.S. Department of Energy gave Oak Ridge a $35-million award to build and operate the lab, which will include a pilot plant capable of producing up to 25 tons a year of new carbon-fiber materials.
- **MegaMagnets**. Rare earth materials are vital to the manufacture of wind turbines, electric and hybrid cars, and consumer electronics due to their powerful magnetic properties. Yet they are also expensive and come almost entirely from one source—China. Whereas electric motors use magnets to transform electrical energy into mechanical energy, sintered rare earth magnets produce incredibly strong magnetic fields at small sizes, allowing manufacturers to build smaller, lighter motors. Their goal is to make magnets with increased electrical resistivity that can reduce motor efficiency losses even when motors operate at high speeds. **Designer NanoCrystals.** Three University of Chicago chemists have created a new way to assemble what they call "designer atoms" into novel materials with a broad array of potentially useful properties and functions. These designer atoms are nano crystals—tiny crystalline arrays small enough that new quantum phenomena begin to emerge but large enough to provide building blocks for new functional materials and substances that could be useful in harvesting solar energy and delivering quantum computing. Greg Engel, associate professor in chemistry, has developed a femtosecond laser system used to dissect couplings between nano crystals.
- **Rock - Solid Coating**. Engineers from the Oak Ridge and Lawrence Livermore national laboratories, the Colorado School of Mines and elsewhere have designed extreme-duty; iron-based, glassy alloy coatings for industrial drill bits, bores and cutters to make this equipment more resistant to breaking even under heavy loads.

NanoSHIELD Coatings—short for Nano Super Hard Inexpensive Laser Deposited Coatings—require a laser to fuse alloy powder to the surface of cutters and other tunnel-boring tools. The coatings cost far less than conventional materials such as tungsten carbide cobalt, and their longer operating life improves the efficiency of the tunnel-boring process.

- **Waste - To - Energy Thermoelectrics**. Northwestern University and Michigan State University scientists have demonstrated a thermoelectric material that is highly efficient at converting waste heat to electricity. That is good news if you consider that nearly two thirds of all energy input is lost as waste heat. The inefficiency of existing thermoelectric materials has limited their commercial use. The record-setting, environmentally stable formulation is expected to convert 15 to 20 percent of waste heat to useful electricity, enabling greater industrial adoption of thermoelectric. Waste-heat recovery systems could be attached, for example, to vehicle tailpipes or could process the exhaust streams from glass- and brick-making factories, refineries, fossil-fuel power plants as well as large transport ships and tankers.
- **Electric Ink**. Quantum-electronic magic can make strange but useful semiconductors that are insulators on the inside and conductors on the surface. The bulk of the material acts as an insulator that blocks electron flow whereas the surface is a very good, metal-like conductor that allows electrons to travel freely at almost light-speed, unaffected by impurities that normally hinder electron motion through materials. Metal-free conductive inks will play a role in making printed electronic materials used in display screens, sensors and batteries. University of Illinois researchers, for example, have created a silver-based electric ink that leaves a trail of conductive material when it evaporates. The new formulation is easier to make than conventional electronic inks, adheres to many materials and can be printed at a lower temperature using a simple desktop device.
- **Fungal Foam**. Initially conceived as a cost-effective, environmentally friendly and high-performance alternative to Styrofoam, Ecovative Design makes its Mushroom Packaging from agricultural crop waste—plant stalks and rice and wheat husks—bonded together with mushroom roots (called mycelium). The company is now adapting its mushroom material to produce biodegradable alternative to petroleum-based plastic foams used in automotive bumpers, doors, roofs, engine bays, trunk liners, dashboards and seats. Other potential uses include tabletops, surfboards and clothing.
- **Iron Glass**. Developed by professor at Yale University. This material allows the creation of a variety of shapes with minimum energy consumption. Here it is worth

noting that in the solid-state iron in the glass is 50 times stronger than plastic and is 10 times - alumina. This can significantly reduce the amount of scratching in the phone. Another advantage of the case of a material - a lower product weight and thickness than the analogues of plastic / metal.

Figure 16 - Iron Glass (from: http://trended.ru/2014/09/steklyannoe-zhelezo-prekrasnyj-material-dlya-zashhitnogo-kejsa/, 25.12.2014)

Trends in the industry of toys

Among toy trends, we can call the following:

- **Sensory Toys**. Built in modern toys sensors allow to respond to light, touch, vibration, sounds. The microprocessor inside handles all the incoming signals of the external world, as well as manages the development of toys. Such kind of toys becomes more self-developing and tsuitable for learning.
- **Microprocessors Toys.** Traditional games and toys are becoming more «robotic» because an increasing number of toys fitted with electronics. Technology is one of the main trends in the toy market.

Figure 17 - Mobile Phone and Tablet for Children (from: http://www.science4you.pt, 25.12.2014)

- **Licensed toys**. Licensed products are another trend in the world of toys. Licenses, particularly movie licenses, continue to be major drivers of toy sales. Every year, sales of licensed of toys are increasing. The reason why the licensed segment grows at the expense of all other products is that licenses provide a number of major benefits. A good license is a key that opens important doors. It exploits consumer awareness of a movie or TV character, and hence enhances the appeal of a product. It also leads to an impulse purchase in the store.

Figure 18 - Gadgets Ben10 (from: http://www.cartoonwatcher.com/ben10/ben10-wallpapers/ben10-wallpaper-15.php, 25.12.2014)

- **Personalized toys.** The trend of personalization toy begins to grow on the market recent years. Every year there are more and more products for the child to create a unique toy with their hands on their taste.

Figure 19 - Handbags for Coloring (from: http://www.kids-price.ru/color_me_mine_gorodskoj_stil_3596665.html, 25.12.2014)

- **Several in one.** Two, three, four, five in one ... Modern toys are increasingly combining several game, developmental or learning function, creating as much as possible options for entertainment for child. Such a system can significantly save space in child's room and finances for parents. For example LEGO. You can buy

one Record Breaker at the price of 19, 99 or monkey, cute teddy bear and squirrel (3 in 1) at the same money.

Figure 20 - LEGO Record Breaker (from: http://www.lego.com/en-US/Record-Breaker-42033?fromListing=listing, 25.12.2014)

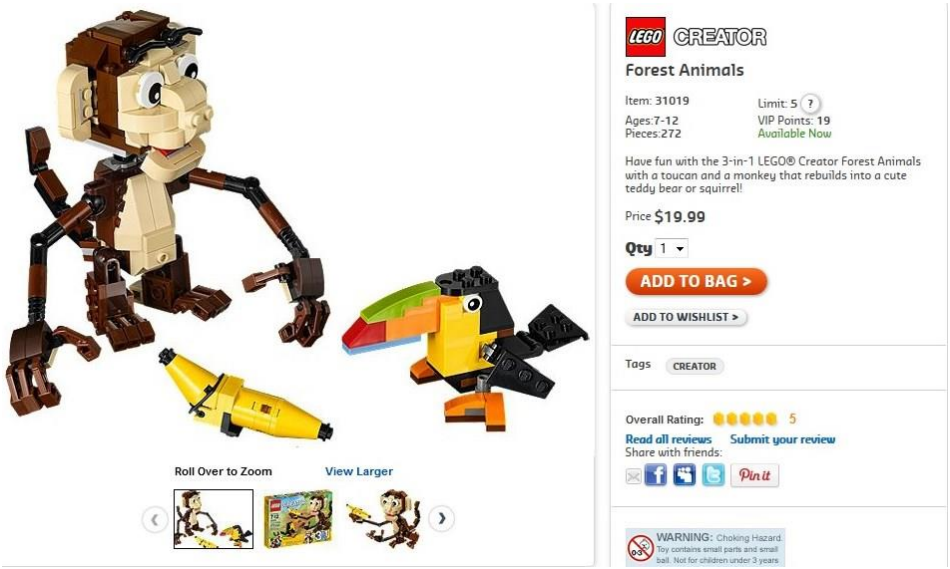


Figure 21 - LEGO 3 in 1 (from: http://www.lego.com/en-us/creator/products/3in1models-15.php, 25.12.2014)

- **Eco-friendly.** Another area that has become topical in the toy market is eco-friendly line. On the one hand, toys are becoming more environmentally friendly. On the other hand, children learn to cherish our planet.

Figure 22 - Eco Greenhouse (from: http://www.science4youtoys.com/store, 25.12.2014)

REFERENCES

Afeyan, Noubar. *Top 10 emerging technologies for 2014.* 1 September 2014. https://agenda.weforum.org/2014/09/top-ten-emerging-technologies-2014/ (accessed January 15, 2015).

Agarwal, Tarun. *Introduction to Screenless Displays with Their Types.* 2013. https://www.elprocus.com/introduction-to-screenless-displays-and-their-types/ (accessed December 26, 2014).

Ben 10. n.d. http://www.cartoonwatcher.com/ben10/ben10-wallpapers/ben10-wallpaper-15.php (accessed December 26, 2014).

"Ben 10 Toy Line From Bandai." *http://toynewsi.com.* 06 07 2006. http://toynewsi.com/news.php?catid=78&itemid=9823 (accessed april 10, 2015).

Cini4kin. *Iron Glass.* 10 September 2014. http://trended.ru/2014/09/steklyannoe-zhelezo-prekrasnyj-material-dlya-zashhitnogo-kejsa/ (accessed December 26, 2014).

Five coolest eco friendly toys for your little ones. 2014. http://www.greendiary.com/coolest-eco-friendly-toys.html (accessed January 15, 2015).

Gajitz » Meta » Technology. 2015. http://gajitz.com/meta/technology/ (accessed January 15, 2015).

Green Toys. 2015. http://www.greentoys.com/toys.html (accessed January 15, 2015).

Green Toys Recycled Plastic Cookware And Dining Set Review. 8 August 2014. http://www.thebrickcastle.com/2014/08/green-toys-recycled-plastic-cookware.html (accessed December 26, 2014).

Greenemeier, Steven Ashley and Larry. *9 Materials That Will Change the Future of Manufacturing [Slide Show]*. 22 April 2013. http://www.scientificamerican.com/article/9-materials-that-will-change-manufacturing/ (accessed December 26, 2014).

Innovative Materials and Technologies. 2015. http://www.mirexpo.ru/exhibitions/imtech.shtml (accessed January 15, 2015).

LEGO Products . 2015. http://www.lego.com/en-us/products (accessed December 28, 2014).

Science4you. 2014. http://www.science4youtoys.co.uk/about-us/company (accessed December 26, 2014).

Trend. 2015. http://www.merriam-webster.com/dictionary/trend (accessed December 26, 2014).

Znatok. 2015. http://babadu.ru/store/vendor/znatok/ (accessed December 20, 2014).

MATERIALS AND TECHNOLOGIES

For the production of toys, people use different materials and technologies. We consider some of them.

METAL

Recently, the use of metal for the production of toys is reduced for several reasons (safety, cost). Nonetheless, some toys, such as scale models of automobiles, aircraft, construction equipment and trains, transformers, parts of electrical constructors, other use real metal. The metal used is either a lead alloy (in the first toys), or more commonly Zamak (or Mazak in the UK) - zinc, aluminum, magnesium and copper. Usually it is an alloy of zinc with small quantities of aluminium and copper. Technology for the production of toys from these materials is called die-casting method.

A large container with metal is put into a hot barrel designed to melt its contents. When it has melted, a screw-type plunger starts pushing it through a nozzle, filling a mold - specific shape for a toy. The mould is usually kept at a specific temperature so that the toy can harden.

A similar method can also be used for plastic.

Figure 23 - Die-Cast Cars (from: http://www.laughingplace.com, 27.12.2014)

PLASTIC

Plastic is the most accessible and widely used material for the production of toys. The manufacturing process of plastic toys is blowing or casting the molten mass into a special mold. Modeling of products is done by software. All technology of production of

plastic toys can be divided into the following stages: supply of raw materials in a screw machine, its grinding and heat treatment and finally injection into the mold under high pressure. Alternative fabrication is blowing plastics into a mold that is in contact with only one surface material. The advantage of this method is reducing the cost of the product due to a significant reduction in materials.

Nowadays, we are thinking more about the environment in all parts of our daily life. Therefore, eco plastic is very popular in the manufacture of toys.

Figure 24 - Green Toys Recycled Plastic Cookware (from: http://www.thebrickcastle.com/2014/08/green-toys-recycled-plastic-cookware.html, 27.12.2014)

WOOD

Wooden toys are the most environmentally friendly. Such toys are not equipped with electronic gadgets and quite simple in design. You can make them by yourself. At the same time, the wooden toy is not toxic. That is why these toys are the best natural gift for a child. «*Wooden toys are divided into pure wooden toys, synthesis wooden toys, and wooden assisted toys. With contacting and practical processing of modern technology, wooden toys have made themselves diversified, and enriched the function of toys themselves»* (Blog 2013)**.**

Figure 25 - Magic Cube Ball (from: http://www. tinydeal.com/2013/12/11/wooden-toys/, 27.12.2014)

3D printing of the toy becomes one of the new directions in the field of technology. This technology can use different materials, but safety remains the main criterion in choosing of the material for both 3D printing, and a classical production.

Thus, metal, plastic and wood are the main materials for the production of toys. Die-casting method is one of the most common. In recent years, 3D printing adds a number of traditional technologies for the production of toys. Nevertheless, safety remains a major criterion in choosing of material.

REFERENCES

Afeyan, Noubar. *Top 10 emerging technologies for 2014.* 1 September 2014. https://agenda.weforum.org/2014/09/top-ten-emerging-technologies-2014/ (accessed January 15, 2015).

Amery, Seth. *How Are Die-cast Toys Made?* . 2015. http://www.ehow.com/how-does_5150721_diecast-toys-made.html (accessed January 15, 2015).

Blog, Tinydeal. *Wooden Toys.* 11 December 2013. http://blog.tinydeal.com/2013/12/11/wooden-toys/ (accessed December 27, 2014).

Die-cast toy. 2014. http://en.academic.ru/dic.nsf/enwiki/689362 (accessed January 15, 2015).

Eco Toys. 2011. http://www.ifpaenergyconference.com/Eco-Toys.html (accessed January 10, 2015).

Fine Wood Toys for Your Children's Children . n.d. http://www.woodentoy.com (accessed January 18, 2015).

Five coolest eco friendly toys for your little ones. 2014. http://www.greendiary.com/coolest-eco-friendly-toys.html (accessed January 15, 2015).

Green Toys. 2015. http://www.greentoys.com/toys.html (accessed January 15, 2015).

Green Toys Recycled Plastic Cookware And Dining Set Review. 8 August 2014. http://www.thebrickcastle.com/2014/08/green-toys-recycled-plastic-cookware.html (accessed December 26, 2014).

Greenemeier, Steven Ashley and Larry. *9 Materials That Will Change the Future of Manufacturing [Slide Show]*. 22 April 2013. http://www.scientificamerican.com/article/9-materials-that-will-change-manufacturing/ (accessed December 26, 2014).

Innovative Materials and Technologies. 2015. http://www.mirexpo.ru/exhibitions/imtech.shtml (accessed January 15, 2015).

Wooden Toys. 2015. http://www.ehow.com/hobbies-games/toys/wooden-toys (accessed March 10, 2015).

Wooden Toys Versus Plastic Toys . 06 May 2014. http://www.blog.greenbeekids.co.uk/2014/05/why-natural-wooden-toys-beat-plastic.html (accessed January 18, 2015).

ARGUMENT

To develop and implement an object (or group of objects) for children of 5-10 years that allows in a simple and entertaining way to attach children to the complex world of science.

CASE STUDIES DESCRIPTION

Based on the key aspects of the design voiced by Buchanan (Buchanan 2011) and Papanek (Papanek 1984) we will try to formulate criteria that will help us to analyze existing products on the toy market.

Shape, color, texture

- Do you like the color?
- Do you like the shape?

Psychology

- What kind of emotions does the object call?
- Is this object interesting?
- Is this object fun?
- Do you want to buy it?
- What kind of associations has this object?

Is it necessary?

- Does it contribute to child development (Attention, Memory, Intellection, Language, and Perception)?
- Does it facilitate the development of motor skills?
- Does it promote creativity?
- Does it help to the physical development of the child?
- Is there connection with science?

Does it work?

- Is the idea of the designer clear?
- Is there a clear manual, instructions?
- Is it convenient to use?
- Is it safe for users?
- Is it necessary to have an adult to help?
- How many times can we play?

Materials

- What kind of material is this object made from?
- What kind of production process are manufacturers using?

Environment

- Is it possible to recycle, reuse?
- Is it safe for the environment?

In our opinion the goods - trends are the most interesting for the review Therefore, we have chosen for analysis such goods as Tab4you (Science4you), Sifteo Cubes, Ben 10 Toy Line, Remote Control Car Model, Forest Animals (Lego), Electronic Constructor ZNATOK, Eco Greenhouse (Science4you) and Wooden Project Building Blocks. We have studied the information that the manufacturer has given us through instructions, packaging and websites and then have asked a group of experts to form an opinion about these toys. To do this, we have offered to experts some videos about toys. As experts, we had sixteen students of five to ten years from The First Slavic School in Lisbon (**http://mir.com.pt**).

Tab4you. Microprocessors toy.

Figure 26 - Tab4you (from http://www.science4you.pt/tech4you/tab4you-iii-detail, 11.04.2015)

As the Science4you claims, Tab4you was developed specifically for children. It is equipped with a number of useful applications such as parental control, e-books and educational very fun games. Size of the screen is 7 inches. The tablet has green plastic body. The developers have included a number of informative educational upgradeable programs that develop concentration, expand vocabulary, and stimulate social interaction. Children can develop memory, attention, logic, creativity and motor skills. The tablet is an

intellectual toy; it does not involve the physical development of the child. This toy does not directly relate to science, but developers can provide this gadget with relevant applications if it is necessary.

The tablet is equipped with a detailed instruction in three languages that considerably simplifies communication between designers and consumers. On the packaging there is a symbol telling us that this product meets the standards of quality and safety of the EU. Unfortunately, we do not have accurate information about whether it is possible to recycle materials or something else. The manufacturer does not give us information about its social responsibility. Considering compliance with European standards, we can assume that most likely this toy is safe for the environment also.

We can buy this tablet for 99, 99 euros. We do not know the price of additional applications, but even without them purchase of this toy will cost the family budget. However, communication with experts showed that 10 people (63% of respondents) already have a similar high-tech, personal assistant. In addition, we have asked children to answer some questions about this toy. Experts had to answer positively or negatively. We have systematized their answers.

Table 2 - Tab4you. Evaluation of experts

Questions	**Positive answer**	**%**	**Negative answer**	**%**
Do you like the color?	12	75	4	25
Do you like the shape?	16	100	0	0
Is this toy interesting?	12	75	4	25
Is this toy fun?	16	100	0	0
Is this toy useful?	16	100	0	0
Is this toy scientific?	11	69	5	31
Do you understand how to play?	16	100	0	0
Do you need help of adults?	3	19	13	81
Do you need a manual?	4	25	12	75
Is this toy safe?	8	50	8	50
Do you want to buy it?	12	75	4	25

As shown in Table 1, 75% of respondents liked the color of the tablet. Experts evaluated the shape of toy. The majority decided that it is an interesting toy. Of course, it is fun. This is useful, but only 69% of respondents have linked toy with science. All have understood how to play with the tablet; only 19% admitted that they need help of adults. Instruction is necessary for 25% of the experts. Participants in an amount of 50% decided that this toy is safe. Most experts wanted to buy this toy, if they had the opportunity. At the

end of the interview, we asked how many days per week children are ready to play with this toy. Answers varied, but six people (38%) would like to play every day.

Sifteo Cubes. Microprocessors toy.

Figure 27 - Sifteo Cubes (from https://www.sifteo.com/cubes, 11.04.2015)

According to the creators of Sifteo Cubes, it is «*a magical new interactive game system built on the timeless play patterns of legos, building blocks, and domino tiles. Tilt, flip, shake, neighbor, press! Sifteo Cubes communicate wirelessly and respond to each other and your gestures. Play an ever expanding catalog of games that challenge and delight»* (Sifteo Cubes 2015). Traditional set consists of three white wireless blocks in shape and size close to iPod (possible options 6 and more). The developers of these cubes argue that this fun exercise.

When we work with these cubes, we can develop spatial reasoning, logic, concentration, vocabulary, etc., motor skills are involved. There is an opportunity to develop creativity (it depends on the software). Physical development of children is not provided. This gadget is not associated directly with science, but it can be solved.

The body of cubes is made of plastic. Naturally, there are also microprocessors and electronics. We do not know for sure whether components of cubes are possible to recycle. We also do not know about the social obligations of the company and we hope that this product complies with the standards.

It is difficult to buy this toy in usual shop; we must specially order it. Price on Amazon is 150, 00 euros for a basic kit. We think that upgrade will also cost money.

After talking with experts, we found the following: all participants liked the color. The majority (75%) liked the shape. For 75% of respondents it became clear that it is fun and interesting toy. No doubt, this is useful toy. About half of experts (56%) have linked this toy with science. Children in general (69%) understood how to play with cubes. Help of adults is required for 19% of the experts; 44% would study instructions. The majority of experts (75%) concluded that it is a safe toy. The desire to buy Sifteo Cubes appeared in 75% of children. Children would like to play with this toy often during the week, four people (25%) dreamed to play every day. Survey results are presented in Table3.

Table 3 - Sifteo Cubes. Evaluation of experts

Questions	**Positive answer**	**%**	**Negative answer**	**%**
Do you like the color?	16	100	0	0
Do you like the shape?	12	75	4	25
Is this toy interesting?	12	75	4	25
Is this toy fun?	12	75	4	25
Is this toy useful?	16	100	0	0
Is this toy scientific?	9	56	7	44
Do you understand how to play?	11	69	5	31
Do you need help of adults?	3	19	13	81
Do you need a manual?	7	44	9	56
Is this toy safe?	12	75	4	25
Do you want to buy it?	12	75	4	25

Ben 10 Toy Line. Licensed toys.

Ben 10 toy line was created based on popular cartoon film. This line includes 10 creatures that Ben can transformed. Naturally, that *«the majority of the toys can "meta-morph" into other toys, such as squirt guns, binoculars, and flashlights, etc.»* (Ben 10 Toy Line From Bandai 2006)

Figure 28 - Ben 10 Toy Line (from http://toynewsi.com/ig.php?mode=view&album=Reviews%2FBen_10&pic=24.jpg&dispsize=800&start=0&sl, 11.04.2015)

Action figures made in colors that match the colors of cartoon characters. This toy will be interesting to all fans of Ben. Taking into account the fact that the figures are for role-playing games, imagination, memory and linguistic skills are trained actively during this kind of activities. Toy promotes the development of motor skills, but it does not help to physical development. It is not scientific toy. There is Quick Start Guide. Figures made of plastic by injection molding. We have indirect information about whether the plastic is

safe for the environment. It is possible to buy these figures in any toy store. Average price is around 12, 00 euros.

Despite the fact that the price is reasonable and figures appeared on the market some time ago, only 19% of our experts have such figures. The number of people who liked the color is 44%. Respondents in an amount of 25% endorsed the shape of the toy. The same number of experts has decided that this toy is interesting and fun. Only 19% said that the toy is useful. Ben 10 Figures are not scientific toys and all experts believe this. Children understood how to play with these figures (the number of positive answers was 69%). Help of adults is necessary for 13% of experts and 25% want to meet with the instruction. Experts (69%) believe that this toy is safe. A third of respondents have a desire to buy this toy. For this toy children singled out 2 days per week. Survey results are presented in Table4.

Table 4 - Ben 10 Toy. Evaluation of experts

Questions	**Positive answer**	**%**	**Negative answer**	**%**
Do you like the color?	7	44	9	56
Do you like the shape?	4	25	12	75
Is this toy interesting?	4	25	12	75
Is this toy fun?	4	25	12	75
Is this toy useful?	3	19	13	81
Is this toy scientific?	0	0	16	100
Do you understand how to play?	11	69	5	31
Do you need help of adults?	2	13	14	87
Do you need a manual?	4	25	12	75
Is this toy safe?	11	69	5	31
Do you want to buy it?	5	31	11	69

Remote Control Car Model. Licensed toys.

Figure 29 - Honda CR-Z (from http://www.amax-toys.com/e/RC_Toy/Licensed_car/Honda/LC-023801.html, 11.04.2015)

Line number of such toys is very diverse. We will analyze Honda CR-Z. This toy is available in three colors, white, red and black and the shape corresponds to a real car. This toy is not an intellectual one; it is not associated with science. Motility of hands is present. The car has a brief instruction. Toy consists of plastic, rubber and electronic devices. We have no information whether it is safe for the environment. The cost of this toy is about 25, 00 euros.

A third of our respondents possess a similar toy. All participants endorsed colors, 75% adopted the shape of toy. The majority (63%) concluded that the toy is interesting; for 75% of the experts it is fun. This toy is useful for 69% of children. In addition, 44% of respondents believe that it is a scientific toy. Everyone understood how to play, but 25% would accept help from an adult and the same number would like to read the instructions. According to 75% of the experts, this toy is safe. The number of those who want to buy remote control car constituted 75%. The number of days to play with this toy varied from 2 to 7 per week. Survey results are presented in Table5.

Table 5 - Honda CR-Z. Evaluation of experts

Questions	Positive answer	%	Negative answer	%
Do you like the color?	16	100	0	0
Do you like the shape?	12	75	4	25
Is this toy interesting?	10	63	6	37
Is this toy fun?	12	75	4	25
Is this toy useful?	11	69	5	31
Is this toy scientific?	7	44	9	56
Do you understand how to play?	16	100	0	0
Do you need help of adults?	4	25	12	75
Do you need a manual?	4	25	12	75
Is this toy safe?	12	75	4	25
Do you want to buy it?	12	75	4	25

Forest Animals. Several in one.

Figure 30 - Forest Animals (from http://shop.lego.com/en-PT/Forest-Animals-31019?p=31019#shopxlink, 11.04.2015)

Forest Animals is a set from Lego presented in Creator Series. The set consists of toucan and a monkey that rebuilds into a cute teddy bear or squirrel. Animal figurines made in beige and brown colors that match the color of real animals. The shape of animals is a schematic that caused by specificity of constructor. During assembly of figures fine motor skills work. This constructor does not affect the physical development of the child and does not relate with science.This toy has many small parts. Due to the part of constructor is a standard, we have a large field for creativity. If you lose some detail, the company will restore it for you.

Lego company has a social responsibility to the children, and the planet, that is why *«LEGO Toys meet or exceed all mandatory safety requirements as well as voluntary industry standards»* (Responsibility at the LEGO Group 2015).

We can buy this set at a price of 18, 99 euros.

Communicating with children has shown that 56% of respondents have a similar toy. All children are satisfied with the color. Participants in an amount of 75% liked the shape of toys. This toy is interesting for 69% of experts, and no doubt, this is a fun toy. It is obvious that Lego is useful. Half of the experts believe that it is a scientific toy. Everyone knows how to play with Lego. However, 19% would like to get help of adults. For 69% of respondents instruction is required. The majority of experts (75%) were sure that it is a safe toy. Everybody wants to buy Lego. A third of respondents would play with Lego every day during the week. Survey results are presented in Table 6.

Table 6 - Forest Animals. Evaluation of experts

Questions	**Positive answer**	**%**	**Negative answer**	**%**
Do you like the color?	16	100	0	0
Do you like the shape?	12	75	4	25
Is this toy interesting?	11	69	5	31
Is this toy fun?	16	100	0	0
Is this toy useful?	16	100	0	0
Is this toy scientific?	8	50	8	50
Do you understand how to play?	16	100	0	0
Do you need help of adults?	3	19	13	81
Do you need a manual?	11	69	5	31
Is this toy safe?	12	75	4	25
Do you want to buy it?	16	100	0	0

Electronic constructor ZNATOK. Several in one.

Electronic constructor ZNATOK developed by Russian designers. This constructor gives child an opportunity to be acquainted with the basics of electronics, as well as to collect some very interesting practical schemes, for example, a flashlight, a fan or radio. Parts of constructor are colorful.

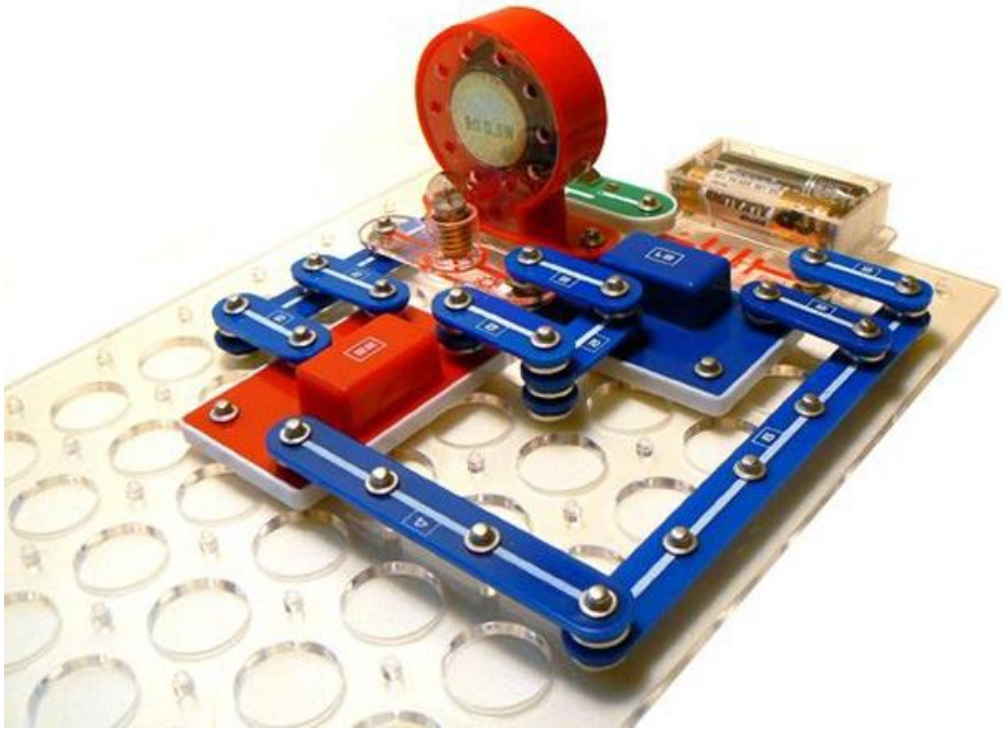


Figure 31 - Electronic constructor ZNATOK (from http://www.znatok.ru/konstruktor_na_320_shem.html, 11.04.2015)

Electric schemes are easy to assemble. Toy helps to develop spatial reasoning, logic, concentration, attention. Motor skills work. There is an opportunity for creativity (the number of lamps, light or sound, all together). This set gives us the opportunity to get knowledge about physics and physical phenomena. Constructor contains detailed instructions. This toy includes 320 electronic circuits. It has plastic and metal parts, but we do not know whether it is possible to recycle. This product corresponds to the Russian standards, but there is no information about whether this product complies with European criteria.The price of the toy is about 50, 00 euros.

Communication with experts showed that 25% of participants have this toy. Most respondents (63%) liked the color of constructor. Toys shape satisfied 69% of participants. For 63% of children, this toy is an interesting one. According to 75% of the participants, this is a fun toy. This constructor is useful. Participants in an amount of 69% understood how to play with this toy. Help of adults is essential for 25% of the experts. To build schemes, it is necessary to read the instructions and all children understand this. This toy is safe in the opinion of 69% of respondents. Number of people wishing to buy this constructor was 75%. A quarter of respondents is ready to play with this toy 7 days a week. Survey results are presented in Table 7.

Table 7 – ZNATOK. Evaluation of experts

Questions	Positive answer	%	Negative answer	%
Do you like the color?	10	63	6	37
Do you like the shape?	11	69	5	31
Is this toy interesting?	10	63	6	37
Is this toy fun?	12	75	4	25
Is this toy useful?	16	100	0	0
Is this toy scientific?	11	69	5	31
Do you understand how to play?	11	69	5	31
Do you need help of adults?	4	25	12	75
Do you need a manual?	16	100	0	0
Is this toy safe?	11	69	5	31
Do you want to buy it?	12	75	4	25

Eco Greenhouse. Eco-friendly.

Figure 32- Eco Greenhouse (from http://www.science4you.pt/ecoscience/estufa-ecologica-detail, 11.04.2015)

Eco Greenhouse (Science4you) is ecological toy for children. This set consists of several components such as seeds, soil, vases, plates, etc. The main component is a greenhouse. Greenhouse has a green body with a transparent cover. Its shape looks like a container. When we play with this toy, we learn, expand our vocabulary and socially interact. Motor skills develop. This kit promotes creativity. The toy does not affect the

physical development of the child. A Quick Start Guide accompanies this kit, besides there is an educational book of 36 pages.

We have indirect information about processing capabilities, as well as about whether it is safe for the environment. Theoretically, the plants are environmentally friendly, but the question with plastic is open. There is no information about the social responsibility of the manufacturer. We can buy a greenhouse at a price of 19, 99 euros.

In our group, 19% of respondents have such toy. Everybody liked the color and the shape of the toy. The majority of respondents (75%) agreed that this toy is interesting one. There is no doubt that this is a fun and useful toy. For 75% of respondents it is obvious that the toy related to science. Children in general understood how to play with greenhouse. Help of adults would be useful for the 19% of participants. In addition, 69% decided that it is important to have manual. According to 75% of respondents, this toy is safe. All people have concluded that they need to buy this toy. Survey results are presented in Table 8.

Table 8 - Eco Greenhouse. Evaluation of experts

Questions	**Positive answer**	**%**	**Negative answer**	**%**
Do you like the color?	16	100	0	0
Do you like the shape?	16	100	0	0
Is this toy interesting?	12	75	4	25
Is this toy fun?	16	100	0	0
Is this toy useful?	16	100	0	0
Is this toy scientific?	12	75	4	25
Do you understand how to play?	12	75	4	25
Do you need help of adults?	3	19	13	81
Do you need a manual?	11	69	5	31
Is this toy safe?	12	75	4	25
Do you want to buy it?	16	100	0	0

Wooden Project Building Blocks. Eco-friendly.

Wooden Project Building Blocks is a set that includes natural wooden blocks designed for unlimited creation. Blocks have simple geometrical shape and color of natural wood. During the game, we develop logic, concentration. Motor skills work. Toy promotes creativity. It has a short instruction. Blocks are made from recycled plantation rubber trees. Company manufacturer guarantees that forests are unharmed and the product comply with the highest Australian and European safety standards. This toy consists of 117 items. The price of this set is 54, 00 euros.

Figure 33 - Wooden Project Building Blocks (from http://www.ecotoys.com.au/store/view-wooden-toys.php?toy=12, 11.04.2015)

Children admitted that 19% of them already have this toy. Experts in an amount of 63% liked the color of toy and 75% gave a positive assessment of the shape. According to 69% of respondents, this toy is interesting and fun. No doubt, blocks are useful. As 44% of respondents decided, this toy is a scientific one. How to play with this toy was clear for 69% of participants. The number of children who need help from adults was 25%. Half of the children would like to see instructions. Experts (75%) concluded that it is a safe toy. Majority of participants (63%) would like to buy the blocks. Children are ready to play with blocks 2 or 3 times a week. Survey results are presented in Table 9.

Table 9 - Wooden Blocks. Evaluation of experts

Questions	Positive answer	%	Negative answer	%
Do you like the color?	10	63	6	37
Do you like the shape?	12	75	4	25
Is this toy interesting?	11	69	5	31
Is this toy fun?	11	69	5	31
Is this toy useful?	16	100	0	0
Is this toy scientific?	7	44	9	56
Do you understand how to play?	11	69	5	31
Do you need help of adults?	4	25	12	75
Do you need a manual?	8	50	8	50
Is this toy safe?	12	75	4	25
Do you want to buy it?	10	63	6	37

At the end of our dialogue, we have asked experts to select three toys that they liked most of all. We have summarized the results and have submitted them as a graphic.

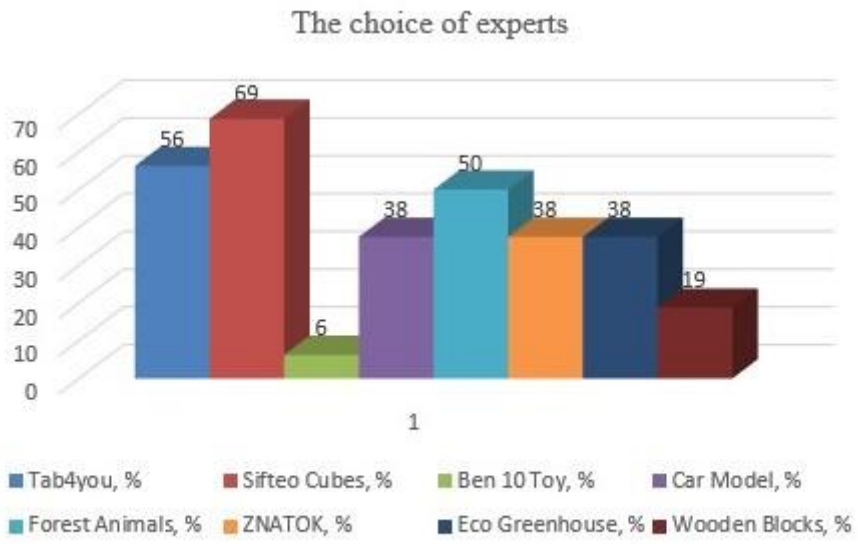


Figure 34 - The choice of experts (N. Lygina, 15.04.2015)

As we can see from the graphic in Figure 34, Sifteo Cubes became leader of the survey. This toy gained 69% of votes. Tab4you took second place with the result of 56%. Lego won third place and got 50%.

We also decided to define three leading positions within the stated criteria (we took into account positive answers).

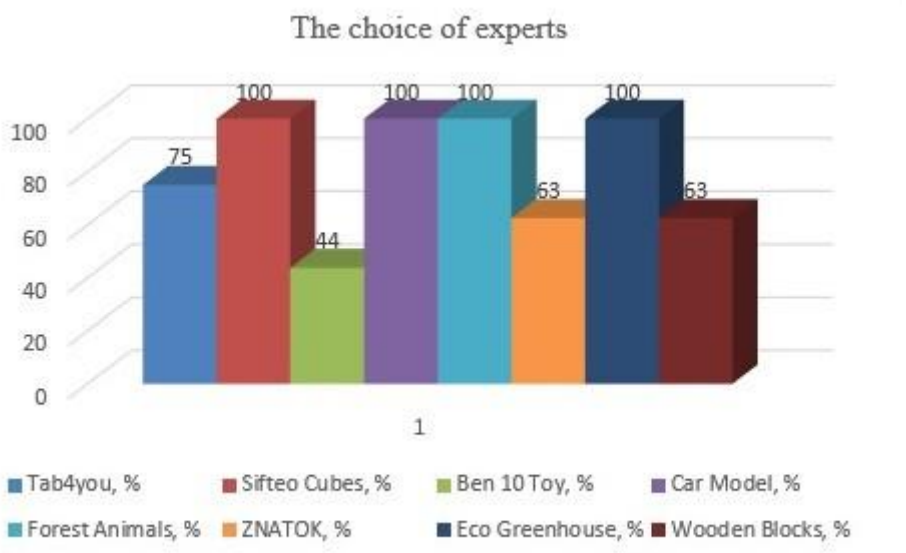


Figure 35 - The choice of experts. Color. (N. Lygina, 15.04.2015)

Analyzing toys in terms of color, we saw that four representatives shared the first prize, they are Sifteo Cubes, Remote Control Car Model, Forest Animals from Lego and Eco Greenhouse from Science4you. Tab4you from Science4you took second place. Third place went to Electronic constructor ZNATOK and Wooden Project Building Blocks.

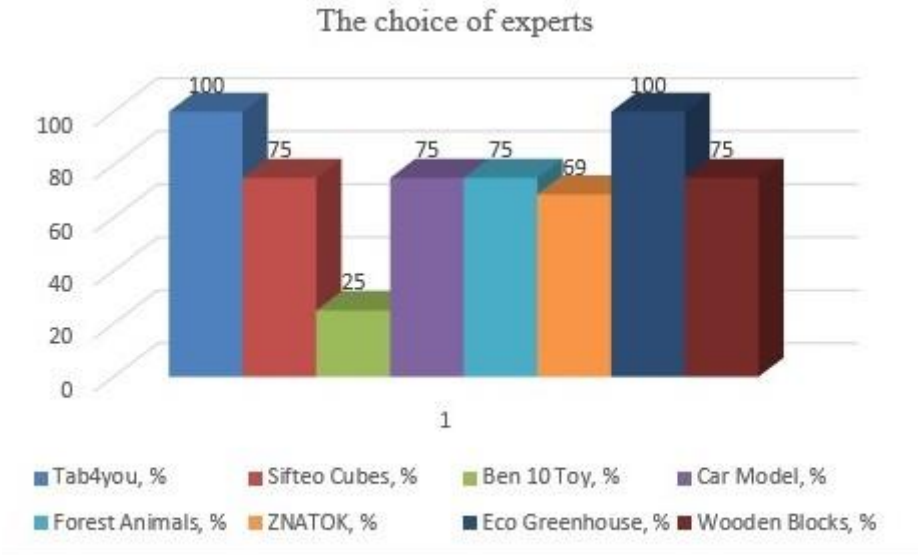


Figure 36 - The choice of experts. Shape. (N. Lygina, 15.04.2015)

Two leaders designated in topic Shape, namely Tab4you and Eco Greenhouse. Sifteo Cubes, Remote Control Car Model, Forest Animals and Wooden Project Building Blocks got second place. Electronic constructor ZNATOK located on the third place.

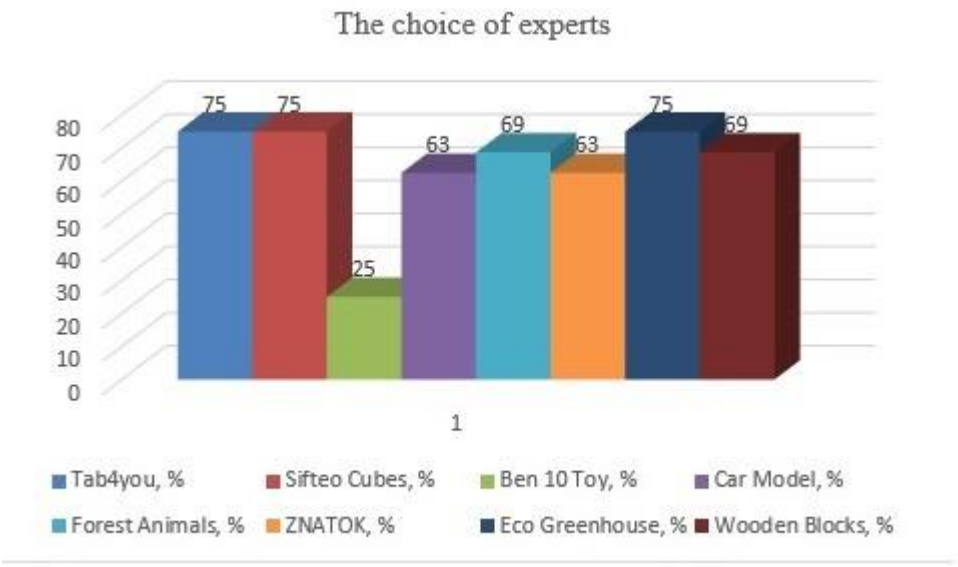


Figure 37 - The choice of experts. Interest. (N. Lygina, 15.04.2015)

Such toys as Tab4you, Sifteo Cubes and Eco Greenhouse have caused special interest. Forest Animals and Wooden Project Building Blocks won second place. Remote Control Car Model and Electronic constructor ZNATOK got the third place.

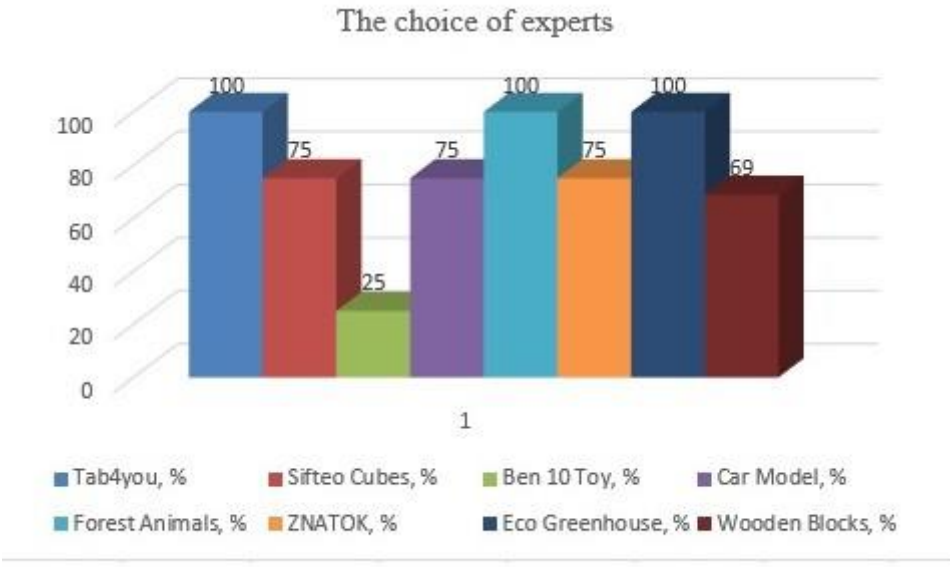


Figure 38 - The choice of experts. Fun. (N. Lygina, 15.04.2015)

Very fun to play with Tab4you, Forest Animals and Eco Greenhouse. Sifteo Cubes, Remote Control Car Model, Electronic constructor ZNATOK located on the second place. Wooden Project Building Blocks closed the list of leaders in this topic.

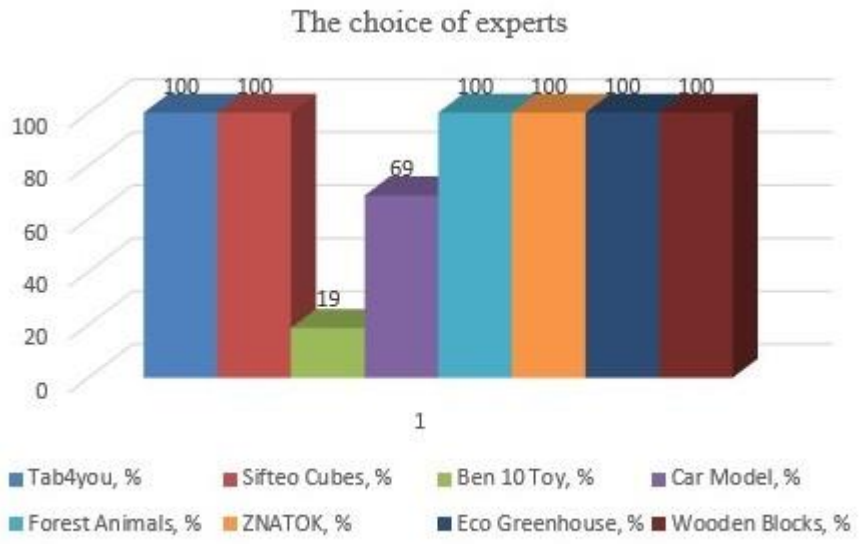


Figure 39 - The choice of experts. Usefulness. (N. Lygina, 15.04.2015)

All toys are useful. Remote Control Car Model and Ben 10 Toys are less useful so they took second and third place accordingly.

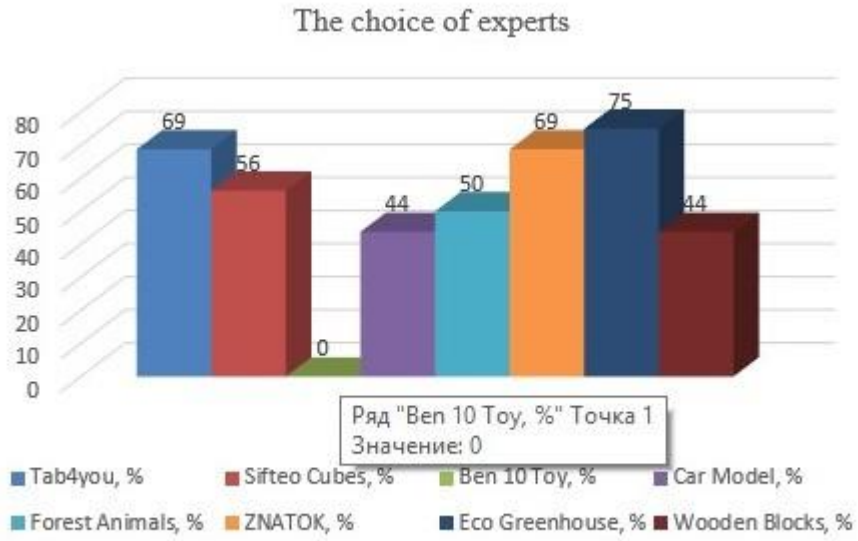


Figure 40 - The choice of experts. Scientific character. (N. Lygina, 15.04.2015)

Eco Greenhouse became the most scientific toy. Tab4you and Electronic constructor ZNATOK got second place. Sifteo Cubes won third prize.

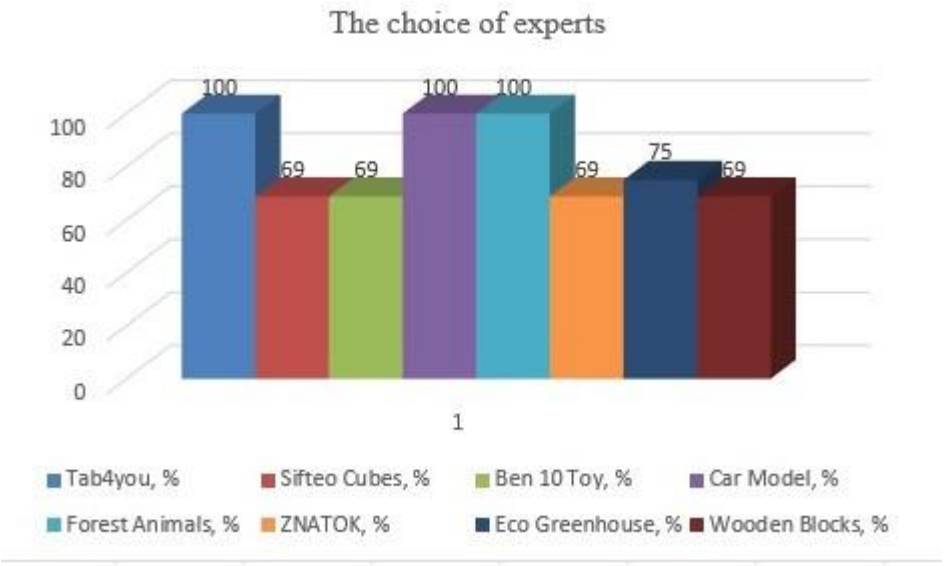


Figure 41 - The choice of experts. Understanding. (N. Lygina, 15.04.2015)

As shown by graphic Tab4you, Remote Control Car Model and Forest Animals became the most understandable toys. Eco Greenhouse took second place. All other participants shared the third place.

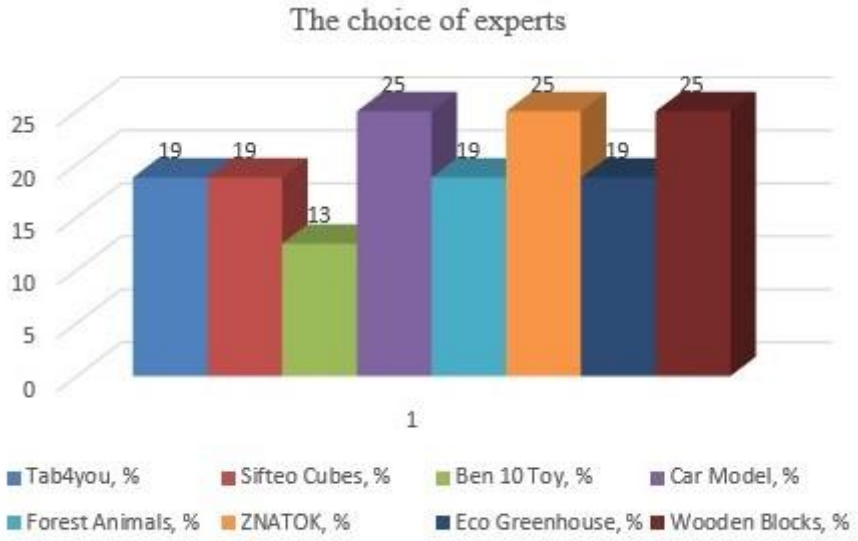


Figure 42 - The choice of experts. Help of adults. (N. Lygina, 15.04.2015)

Remote Control Car Model, Electronic constructor ZNATOK and Wooden Project Building Blocks received first place in the topic Help of adults. Tab4you, Sifteo Cubes, Forest Animals, Eco Greenhouse were placed in second place. Ben 10 Toys got the third place.

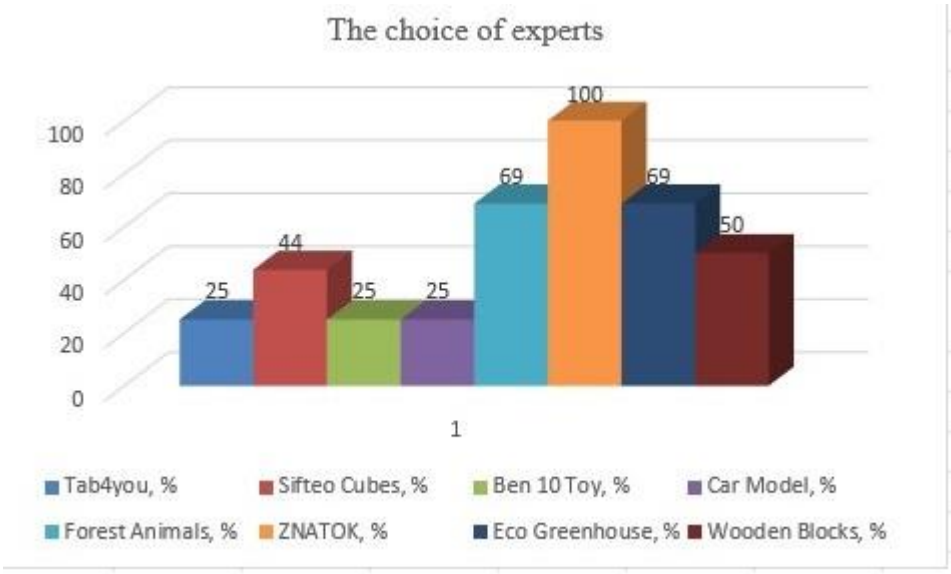


Figure 43 - The choice of experts. Need in instruction. (N. Lygina, 15.04.2015)

Electronic constructor ZNATOK has won in the topic Need in instruction. Forest Animals and Eco Greenhouse shared the second place. Wooden Project Building Blocks closed the list of leaders.

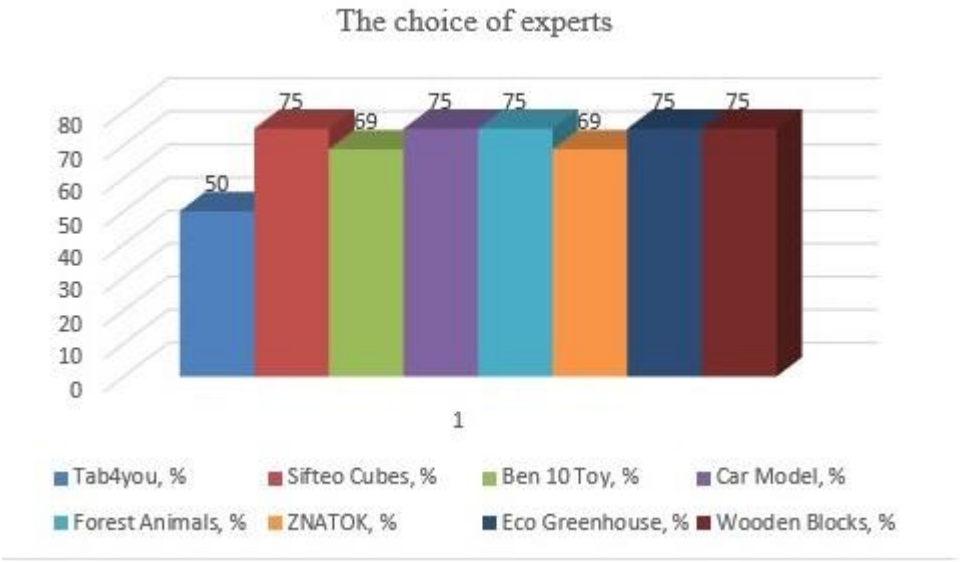


Figure 44 - The choice of experts. Safety. (N. Lygina, 15.04.2015)

According to experts, almost all toys are safe. However, Ben 10 Toys and Electronic constructor ZNATOK seemed less safe so they got the second place. Tab4you received honorable third place.

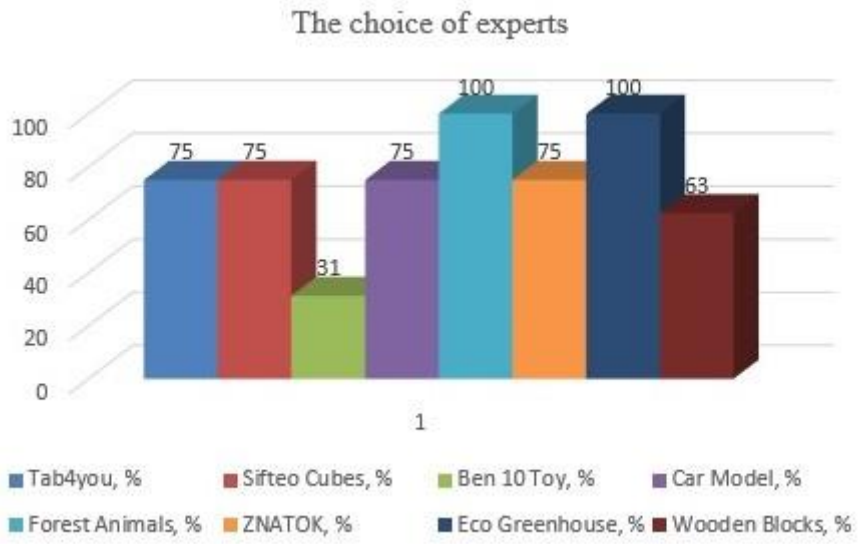


Figure 45 - The choice of experts. Desire to buy. (N. Lygina, 15.04.2015)

First children would buy Forest Animals and Eco Greenhouse. After that, they would think about Tab4you, Sifteo Cubes, Remote Control Car Model and Electronic constructor ZNATOK. Wooden Project Building Blocks ranked third in the list of priority purchases.

Based on data received from experts, we have also decided to call the "perfect toy". Toys that took first place, we have assigned 3 points. We gave 2 points for second place, and for the third place we have left 1 point. We have systematized and have summarized results in the table.

Table 10 - The "perfect toy" in opinion of experts.

	Tab4you	**Sifteo Cubes**	**Ben 10 Toy**	**Car Model**	**Forest Animals**	**ZNATOK**	**Eco Greenhouse**	**Wooden Blocks**
Do you like the color?	2	3	0	3	3	1	3	1
Do you like the shape?	3	2	0	2	2	1	3	2
Is this toy interesting?	3	3	0	1	2	1	3	2
Is this toy fun?	3	2	0	2	3	2	3	1
Is this toy useful?	3	3	1	2	3	3	3	3
Is this toy scientific?	2	1	0	0	0	2	3	0
Do you understand how to play?	3	1	1	3	3	1	2	1
Do you need help of adults?	2	2	1	3	2	3	2	3
Do you need a manual?	0	0	0	0	2	3	2	1
Is this toy safe?	1	3	2	3	3	2	3	3
Do you want to buy it?	2	2	0	2	3	2	3	1
TOTAL	**24**	**22**	**5**	**21**	**26**	**21**	**30**	**18**

As we can see, Eco Greenhouse became the "perfect toy" by opinion of experts. This data will certainly help us in our work.

List of experts:

1. Aleksandr Bezverkhy, 10
2. Aleksandr, 6
3. Anastasia Filonovich, 10
4. Andrey Todchuk, 7
5. Andrey, 7
6. Anton Setkov, 10
7. Daniela Mureyra, 10
8. Elena, 7
9. Emilia Azizova, 10
10. Maksim Melnichuk, 10
11. Margarita Kuznetsova, 6
12. Maria Karlovich, 7
13. Olexiy Lyubchik, 7.
14. Sophia Karlovich, 7
15. Veniamin, 5
16. Yana Syomina, 6

BRAINSTORMING

A brainstorming was held under the guidance of Professor José Rui Marcelino. Brainstorming is a method of solving the problem in which participants offer possible solutions. People use brainstorming to generate ideas. «*Brainstorming combines a relaxed, informal approach to problem solving with lateral thinking. It encourages people to come up with thoughts and ideas that can, at first, seem a bit crazy. Some of these ideas can be crafted into original, creative solutions to a problem, while others can spark even more ideas*» (Osborn 1953, 136). Typically, brainstorming includes the following steps:

- First, it is necessary to set up a comfortable meeting environment.
- Then it is needed to define the problem that you want to solve, and lay out any criteria that you must meet.
- Then the group begins discussion.

Number of participants in brainstorming session was 10 people. The purpose of brainstorming was to identify needs of different categories of operating process of the product as well as to find possible solutions for each category. The following categories were proposed:

- Needs of those who uses,
- Needs of those who buys,
- Needs of those who prescribes,
- Needs of those who sells,
- Needs of those who promotes,
- Needs of those who distributes,
- Needs of those who produces,
- Needs of those who are connected with the material,
- Needs of those who recycles.

If we talk about toys in general, the users are children. People, who buy toys, as a rule, are the parents. Various institutions and ministries prescribe toys; shopping malls, online stores sell them.

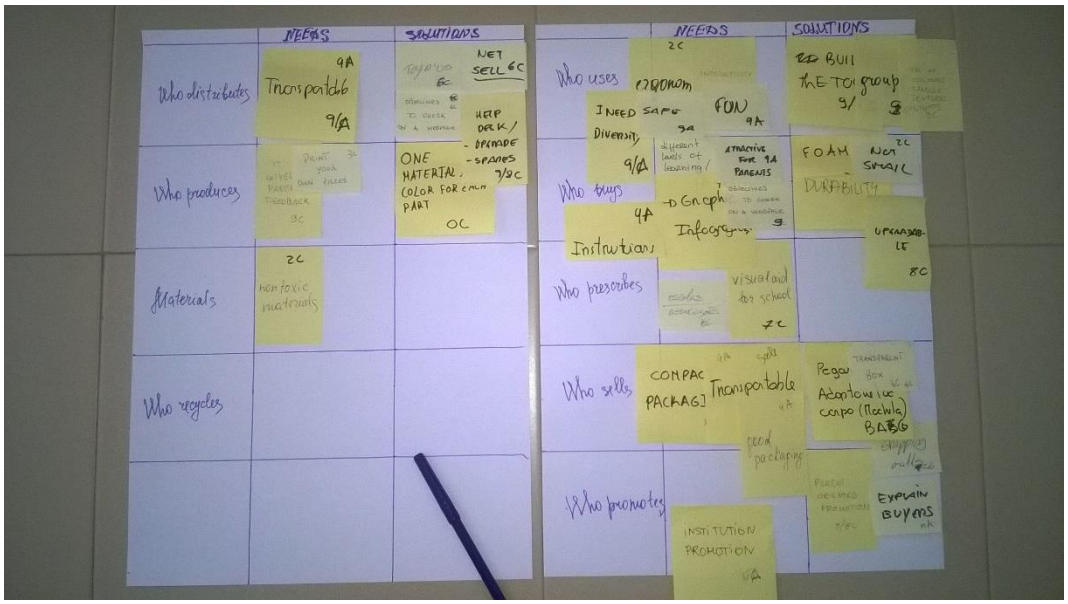


Figure 46 – Brainstorming (N. Lygina, 15.04.2015)

The results of brainstorming session are presented in **Table 11** "Needs of different categories of operating process of the product and potential solutions".

The issues raised in this exercise, as well as potential solutions will help us during work.

Table 11 - Needs of different categories of operating process of the product and potential solutions.

USERS (CHILDREN)	NEED	Instructions.	THAT IS WHY	It is necessary to pay attention to Graphic, infographics.
		To react.		It should be fun.
		To move an object easy.		It should be transportable.
		To be safe		Cutting edges must be absent.
		Diversified objects.		We can use different colors, smells, textures, light.
		To personalize the toy.		May be a possibility to build a toy.
		To develop attention.		Toy should be cognitive.
		To develop memory.		Toy should be educational.
		To develop intellection.		Toy should be developmental.
		To develop language.		Toy should be informative.
		To develop perception.		Toy should be instructive.
		To develop motor skills of hands.		Toy should consist of several parts.
		Psychic development.		Toy must correspond to psychological age.
		To develop creativity.		Toy should be constructive.
		To play.		Toy can be interactive.
		To use toy easy.		It is necessary to pay attention to ergonomics.

BUYERS (PARENTS, TEACHERS)	NEED	Conformity of price and quality.	THAT IS WHY	
		Reusable object.		We need to think about the possibility of upgrading.
		To buy without leaving home.		We want to buy through the Internet
		Guarantees.		We need certified goods.
		Different levels of learning in one object.		We need several in one.
		To have the opportunity to buy spares.		We need help desks.

WHO PRESCRIBES (MINISTRY, INSTITUTIONS)	NEED	To be confident that the product performs its functions at the proper level.		
		To be sure that the product is safe.		
		Age conformity of the goods.		

WHO SELLS (Shopping Malls, Online Stores)	NEED	Competitive product.	THAT IS WHY	We need a quality product at the right price.
		Marketing logistics.		We need good packaging.

WHO PROMOTES	NEED	To inform consumers about the product and its characteristics.	THAT IS WHY	It is necessary to have a good specification.
		To convince a potential buyer.		It should be promotion targeted at parents.
		Institutional promotion.		We need schools and associations.
		Advertisement.		We need promotional events and promotion actions.

WHO DISTRIBUTES	NEED	To protect the product during transportation and storage	THAT IS WHY	We need good packaging.
		The presence of active sales structure.		
		Competent logistics.		

WHO PRODUCES	NEED	Necessary technology.	THAT IS WHY	
		To have production area.		
		To have production capacity.		
		To have possibility of recycling.		
		To have department of control of quality.		It is necessary to have standardized production.
		to have mass production		It is better to have one piece for several models.
		to provide the consumer with spare parts		

MATERIALS	NEED	To comply with the standards.		
		To be inexpensive, but quality.		
		To be lightweight.		
		To be durable.		
		Should be easy in processing.		
		To have the opportunity of recycling.		
		To be safe.		

WHO RECYCLES	NEED	To have technology for recycling.	THAT IS WHY	
		To bear social responsibility.		
		To take care of the environment.		It is better to use materials that are easy to recycle
		To have possibility to recycle or re-use material		

CONCEPT

As we know, physics and chemistry accompany us in everyday life. They are undoubtedly sciences of the future. Considering these factors, taking into account the state of the toy market, we decided to work in this area.

The inspiration for our concept was found in the well-known all over the world entertainment – gyroscope. This toy has many names for example, a top, spinning top, whirligig. We will use the word gyroscope. We offer to think about this object as a tool to study such branches of physics as mechanics and optics. Meanwhile, in our view, this is a good excuse to start a scientific conversation.

In terms of mechanical properties gyroscope shows a number of surprising properties. For example, it keeps a balance only in motion. However, if it stops, it topples. If you push the gyroscope while driving, it will not fall, but will continue to move, taking an upright position. We can run a gyroscope in different ways. If the gyroscope is small and it does not matter how long it spins, we can run it with our fingers. If we want more intense movement, it is possible to use a special mechanism or thread. To run a large gyroscope, we can use screw transmission, which we can put inside the structure. There are also huge gyroscopes. Their weight reaches several kilos. People need to work hard to start a similar construction. However, if they could, the gyroscope may be rotated for hours. Another interesting item is a Chinese gyroscope, because while driving it can jump and roll upside down.

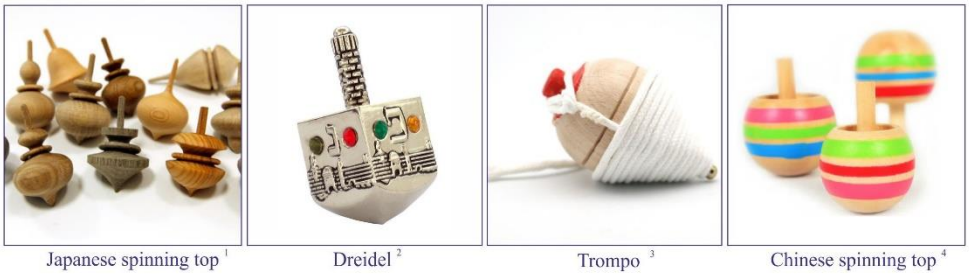


Figure 47 - Gyroscopes of the world (from 1. http://www.notcot.com/images/2010/03/tops2.jpg. 2. http://www.judaicashops.co.il/UploadImages/499531_85103.jpg. 3. http://www.jugarijugar.com/1019-3019-thickbox/baldufa-de-cordill-natural.jpg. 4. http://img02.taobaocdn.com/bao/uploaded/i2/407640416/TB2wzRfaXXXXXcQXXXXXXXXXXXX_!!407640416.jpg)

Optical phenomena are no less interesting. We would like to focus on them, since with it we can make a toy with several options. The simplest solution, which we can use, it is a

mixer of colors. It is possible to paint the top of gyroscope in different colors. When you rotate, the gyroscope colors will be mixed. We can offer a few ready-made solutions, as well as leave space for creativity. To do this it is necessary to offer children a "white" pattern and ask them to paint it.

Figure 48 - Mixer of colors (N. Lygina, 15.04.2015)

Another option, which can be obtained by using the gyroscope top, it is the stroboscope. On the surface we put the pictures in a certain order. Then we rotate our object. As a result we will get a kind of movie that children will appreciate. There are also unlimited opportunities for creativity.

In addition, we can use a mirror surface and look at the principles of reflection. If we take an additional perforated disk and allow it to rotate freely, we can observe the moire effect for some time.

There is also an opportunity to be acquainted with the centrifugal force.

Figure 49 – Stroboscope (N. Lygina, 15.04.2015)

Another toy that we would like to implement is the chemical dices. As we know, chemistry is very interesting and bright science, but it often looks like a boring formula. It happens because chemical experiments are life threatening, as a rule. We want to offer a device that would help to study chemistry without danger to life.

To realize this idea, we need a computer in any form, a set of chemical elements that look like cubes and a special keyboard. Cubes connect to the computer through Wi Fi. Program greets us and asks to select any element. When the choice is made, on the screen we receive colorful explanation of the items that we have selected. After that, the program offers us to choose something else. To organize the reaction there are special options on the keyboard (+, enter, catalysts). When the reaction is made, the screen shows and explains what is happening.

Figure 50 - Chemical dices (N. Lygina, 15.04.2015)

REFERENCES

Axial forces in rotating bodies. 2015. http://energy-source.ru/glava-tri/osevie-sili.html (accessed May 10, 2015).

Chemistry for Life. 2015. http://www.acs.org/content/acs/en.html (accessed December 26, 2014).

Experimentanium. 15 January 2015. http://www.experimentanium.ru/ (accessed December 26, 2014).

Mysteries of the ordinary gyroscope. 2004-2013. http://class-fizika.narod.ru/9_posmotri7.htm (accessed May 18, 2015).

Physics in toys. Spinning Top of Thomson. 2013. http://igrushka.kz/vip79/voltom.php (accessed May 12, 2015).

Science for Kids. 06 February 2015. http://www.sciencekids.co.nz/ (accessed December 20, 2014).

SCIENCE, SIMPLE. *GETTING THE FIRE OF IODINE AND ALUMINIUM.* 17 May 2014. https://www.youtube.com/watch?t=60&v=6LynCavegF8 (accessed May 15, 2015).

Seven most amazing chemical reactions. 17 December 2013. http://buzzbee.ru/samie-effectnie-himicheskie-reakcii.html (accessed May 20, 2015).

Thoisoi. *Compilation of interesting experiments with potassium dichromate.* 01 April 2012. https://www.youtube.com/watch?v=NI5-1rpmKhM&list=PLsOMq-874J1XqEo4VvLeIgni9AvSLsQKi (accessed May 15, 2015).

—. *Liquid nitrogen - Compilation of experiments with liquid nitrogen.* 19 December 2012. https://www.youtube.com/watch?v=HwlgknbeHVo (accessed May 18, 2015).

—. *The best selection of reactions with sodium in history!* 25 April 2012. https://www.youtube.com/watch?v=fFuA8XC8tIM (accessed May 18, 2015).

Top 10 of spectacular chemical reactions. 11 June 2012. http://nibler.ru/flv/11669-10-samyh-effektnyh-himicheskih-reakciy.html (accessed May 15, 2015).

PROTOTYPE TESTING

To test our concept, we sought help from the experts. First, we wanted to know whether the children like to play with whirligig. We were also wondering how they play with it. To do this, we have proposed to experts a paper whirligig (the technique of origami).

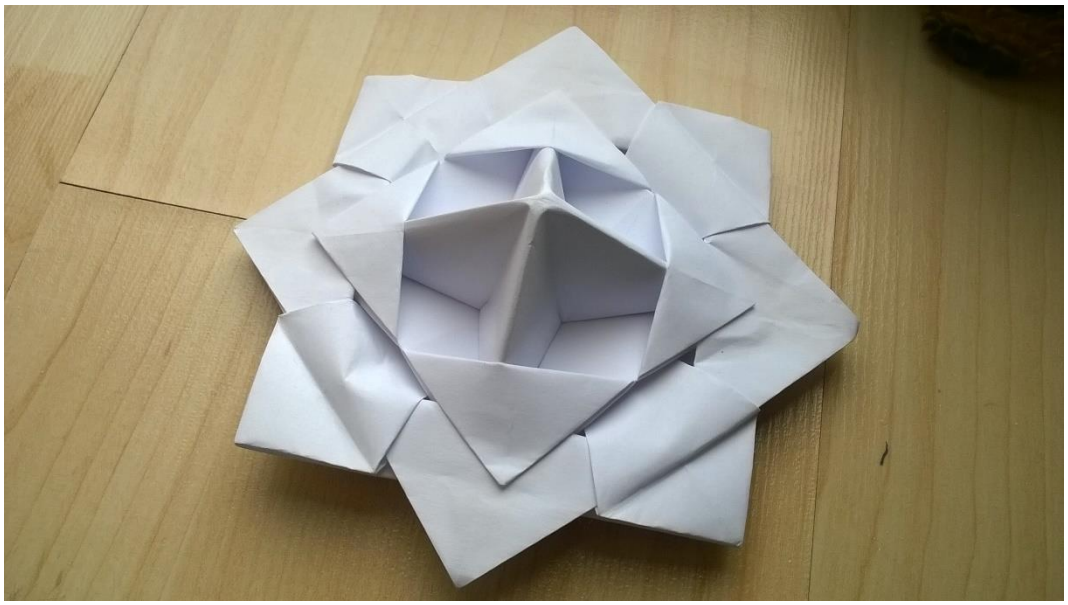


Figure 51 - Paper whirligig, the technique of origami (N. Lygina, 15.04.2015)

We gave models to experts and asked them to comment, what they can do with it. We got a variety of answers. Girls have suggested that perhaps this is an accessory like a hat or a brooch. The boys thought that it could be a ninja star. After some experiments, children concluded that this is whirligig.

Taking into account the fact that the development of creativity occupies a special place in modern education, we asked experts to make whirligig as they wish. For example, to draw something or add color - whatever they want. Because a lesson in the school takes 45 minutes and during that time we had to solve several tasks (problem statement, explanation and clarification of details, discussion and creativity) experts did not have enough time to complete the work. However, we received interesting toys. See the picture below.

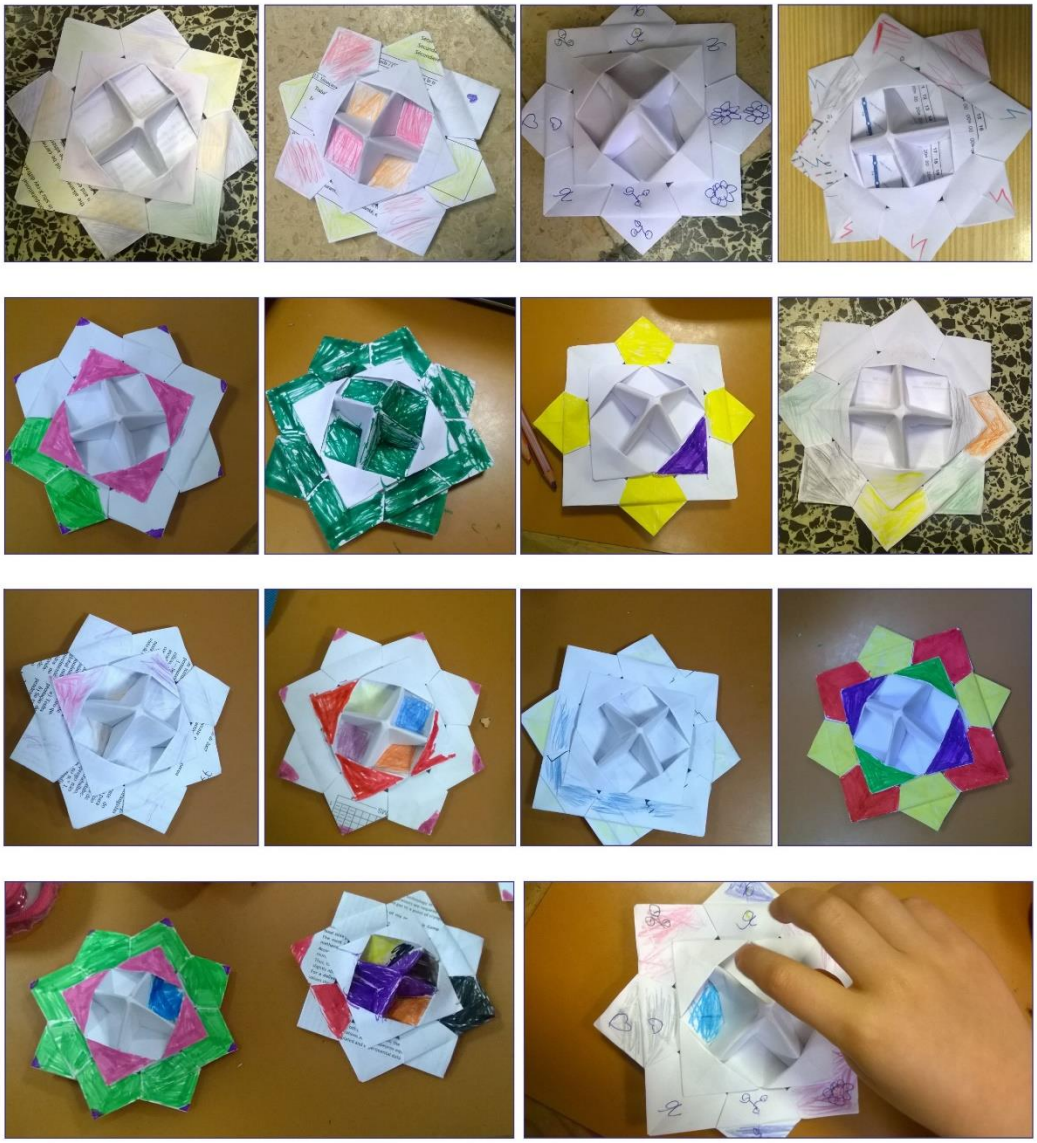


Figure 52 - Toys from experts (N. Lygina, 15.04.2015)

Finally, we asked experts to make an analytical forecast. We asked them to answer some questions.

Table 12 – Experts analytical forecast

Questions	Yes	%	No	%	I do not know	%
Do you like idea of the toy?	16	100	0	0	0	0
Do you think it would be interesting toy	12	75	4	25	0	0
Do you think it would be fun toy?	12	75	4	25	0	0
Do you think it would be useful toy?	16	100	0	0	0	0
Is this toy scientific?	9	56	7	44	0	0
Would you like to buy such toy?	12	75	4	25	0	0

As we can see from Table 12, 75% decided that it could be interesting toy. The same number has suggested that this toy can be fun. All experts have concluded that it would be useful toy. More than half of the experts decided that this toy connected with science. If experts met this toy in the store, 75% of them would buy it.

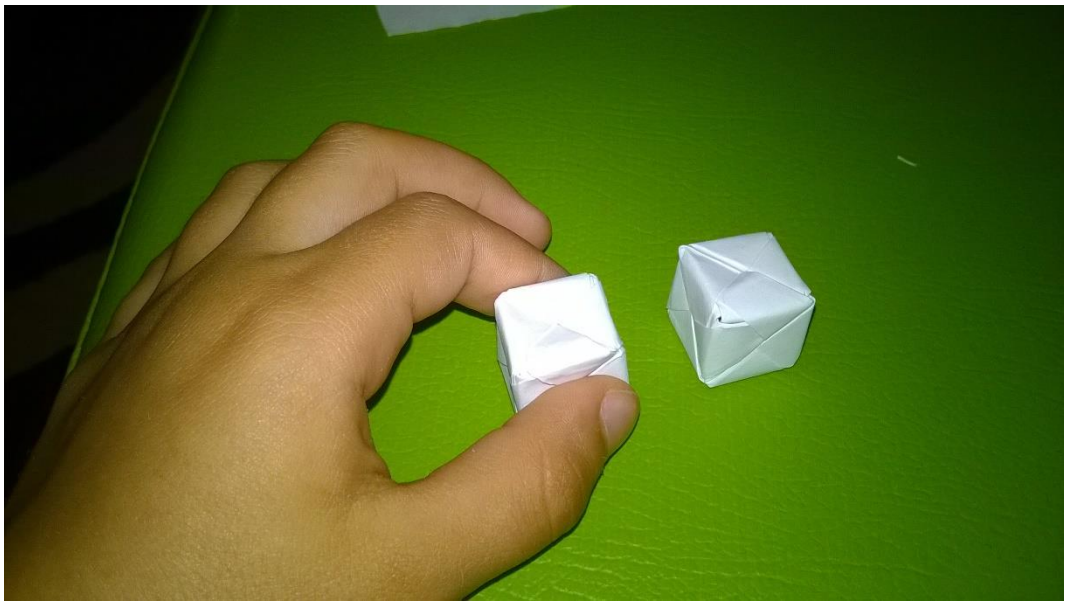


Figure 53 - Paper dice, the technique of origami (N. Lygina, 15.04.2015)

As for chemical dices, we also used the model, made in the technique of origami and video with beautiful chemical reactions. On the surface of paper dice we wrote the name of the chemical elements and figures. We asked children to organize following chemical reactions from cubes:

1. Water and nitrogen (H2O +N = only physical reaction).
2. Water and sodium (2Na + 2H2O = 2NaOH + H2).
3. Water and potassium (2 K + 2 H2O = 2 KOH + H2).
4. Water and cesium (2Cs + 2 H2O = 2 CsOH + H2).
5. Sodium and sulphur (2Na + S = Na2S)
6. Aluminium and sulphur (2Al + 3S = Al2S3).
7. Aluminium and iodine (2Al + 3I2 = 2AlI3).
8. Aluminium and bromine (2Al + 3Br2 = 2AlBr3).

After the cubes were organized, we have shown the corresponding video.

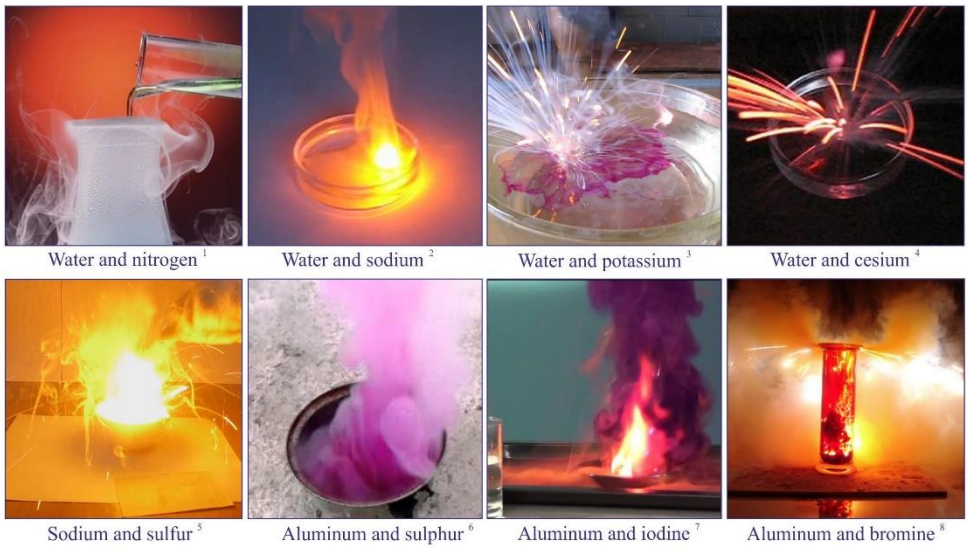


Figure 54 - Beautiful chemical reactions: (from 1.http://chemistry-chemists.com/N1_2013/U6/liquid_nitrogen-196.JPG. 2. http://chemistry-chemists.com/Video-to-Site/Sodium-and-Water.JPG. 3. http://25.media.tumblr.com/tumblr_m16vbxWRun1qch76go1_400.jpg. 4. http://farm4.staticflickr.com/3145/2533888235_65c6db2352.jpg. 5. http://chemistry-chemists.com/Video/sodium-sulfur-21.JPG. 6. http://pandia.ru/text/78/392/images/image034_12.jpg. 7. http://i.ytimg.com/vi/Y3kDZXP4_5A/maxresdefault.jpg/. 8. http://www.chemistrydemos.co.uk/Images/AlBr.jpg. - 15.05.2015)

Finally, we have asked experts to answer some questions. See table «Opinion of experts about Chemistry and Chemical toys».

Table 13 - Opinion of experts about Chemistry and Chemical toys

Questions	**Yes**	**%**	**No**	**%**	**I do not know**	**%**
Do you like chemistry?	5	31,25	4	25	7	43,75
Would you like to study chemistry?	8	50	2	12,5	6	37,5
Do you have any chemical toys?	1	6,25	15	93,75	0	0
Do you like idea of the toy?	13	81	0	0	3	19
Do you think it would be interesting toy?	14	88	1	6,25	1	6
Do you think it would be fun toy?	13	81	0	0	3	19
Do you think it would be useful toy?	16	100	0	0	0	0
Is this toy scientific?	15	94	0	0	1	6
Would you like to buy such toy?	12	75	4	25	0	0

As seen from Table 13, children are not sufficiently familiar with the chemistry, but many experts would like to know more about it. Most of children (81%) liked the idea of the potential toy. Almost all experts (88%) have concluded that it would be an interesting toy. For 81% of children it became evident that it would be a fun toy. On the question, whether this toy is useful, all respondents have given an affirmative answer. In the opinion of 94% of participants, this toy is related with science. If experts met this toy in the store, 75% of them would buy it.

Based on the foregoing we consider that children are interested in this idea. This allows us to move forward and to develop our toys. In addition, children have given us information that we can use in our work (color, decor, exploitation)

ORGANIZATIONAL STRUCTURE

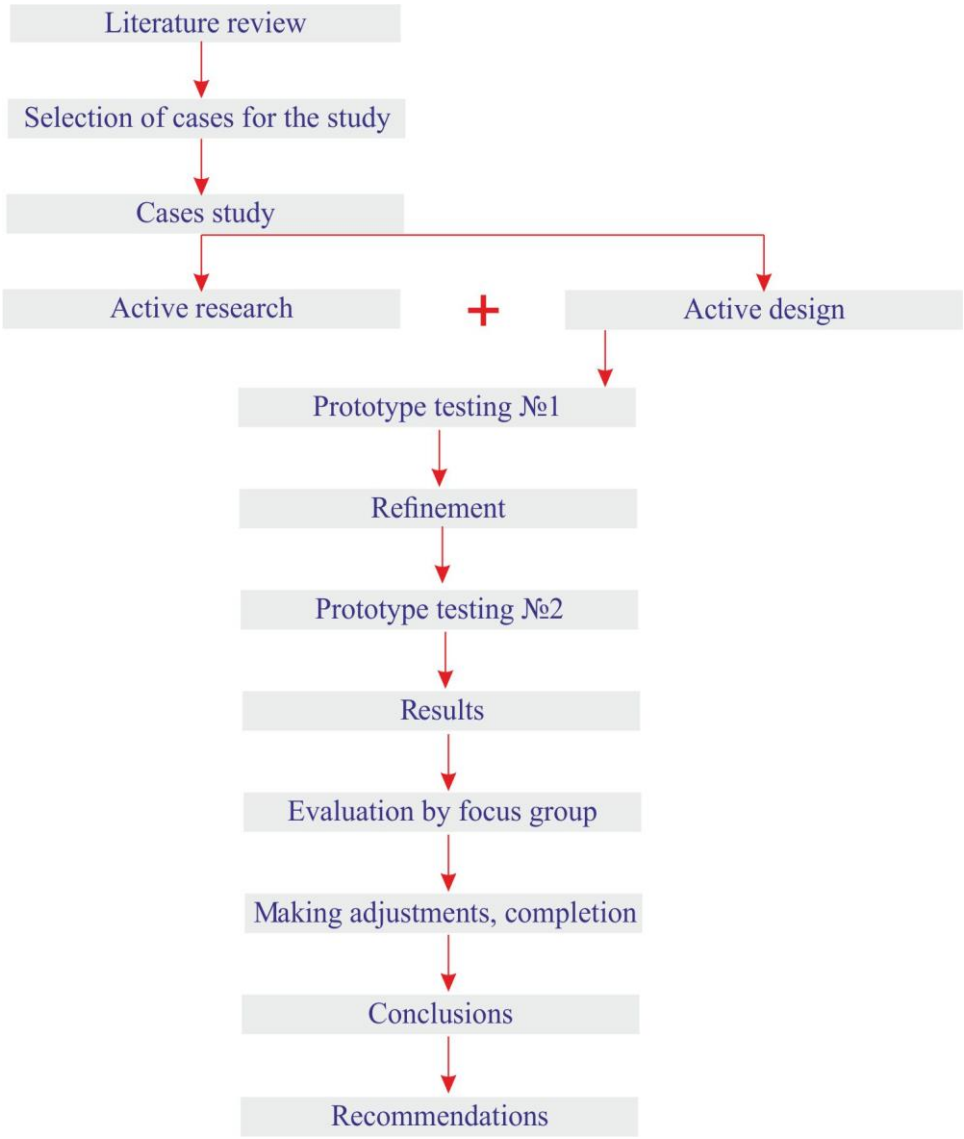


Figure 55 - Organizational Structure (N. Lygina, 15.04.2015)

METHODOLOGY

Developing the question of the organization of our activities, first, we should pay special attention to the methodology. As we know, the methodology is the teaching about methods and procedures, which are used in a particular activity. As we can see from the Figure 55, we have used several methods in our work. Namely Literature review, Situational studying (Cases Study), Active research and Focus – group.

Literature review is nonintervention research, which assumes explanation and interpretation of existing literature sources. That is why the literature review is a qualitative method.

Situational studying (Cases Study) is also nonintervention research. In this method, we analyzed specially prepared situations that are relevant to our problem. Situational studying (Cases Study) is also a qualitative method.

Active research (as well as active design) is intervention qualitative method.

Focus group assumes interaction with certain group of people. That is why it is nonintervention qualitative method.

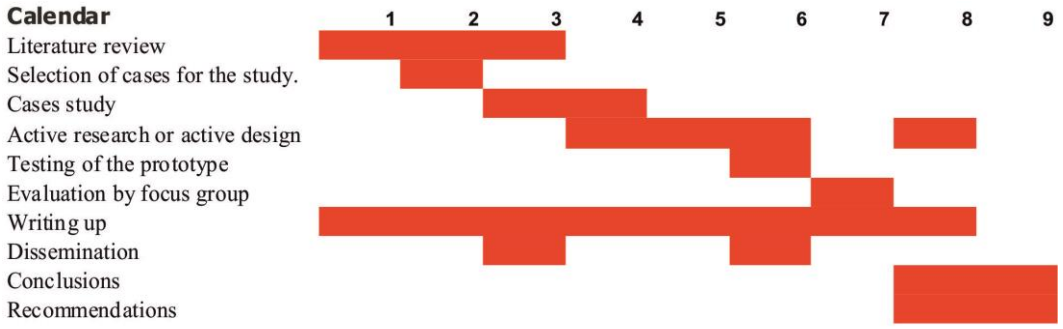
Thus, our methodology includes four methods. It is a mixed methodology.

CRITICAL SUCCESS FACTORS

- To have sufficient knowledge and skills to realize the project.
- To have enough time to realize the project.
- To find persons for the focus group.
- To obtain qualitative feedback.
- To suggest a new and original solution.
- To offer an attractive design.

CALENDAR

Table 14 – Calendar



CONCLUSIONS

Summing up, we can say the following:

Design in general, as well as the design of toys is a complex activity, which is built based on many factors such as physiology, psychology, cultural context, environment, technology and materials, etc.

The key concept of the design process is the ergonomics. The designer must understand the physical and psychological characteristics of people for whom he or she works. Taking into account received information the designer builds relationships with the system, environment and the regulatory authorities.

The user is the most important person for the designer. The needs of the user give the way for reflection to the designer. That is why it is very important to get feedback from the user. Furthermore in an ideal world, the user is not just a person, which gives the feedback, but a full-fledged participant of the design process. In this regard, the designer assumes the role of a teacher who instills good taste to society, provides people with certain tools and explains how to operate them.

We must pay special attention to the learning process, as it is a key area of human functioning. People are learning whole their life, but they get the foundation in childhood. That is why in the modern interpretation learning is transformed into a play. The play allows us to deal with serious things in an easy and entertaining way. Due to this approach, the direction "Science for Children" is becoming very popular in recent years. Creativity is a basic skill in the system of learning through play. In this regard, we need a teacher co-creator. In addition, the teacher is taking on the role of the designer, as well as the function of the designer is expanding with functions of the teacher.

In this context it is natural that toy becomes an instrument of knowledge. That is why the market of scientific toys expands year by year. Manufacturers of scientific toys are working closely with scientific institutes and funding of this direction is carried out at the state level.

RECOMMENDATIONS

When we design a toy, we need to remember that, children should have fun while they are playing. Therefore, the shape, the color, the material should be carefully considered. We also need to pay special attention to the quality of graphics and infographics.

Safety is the most important criterion for toys. That is why when we develop the toy, we have to get light, transportable and compact model. The toy must comply with sanitary and hygienic standards and we need to consider this in our work. Besides that, control of quality and content of toys should be at the highest level.

Educational toy must solve a number of tasks. That is why we need to offer a multifunctional toy. An opportunity to upgrade the toy is solution of this issue. Option "several in one" also solves the problem of the budget.

Financial aspects are actual in the design of toys. Quality toys, as a rule, are expensive. Designers and manufacturers need to look for options to make toys cheaper but the quality should not suffer.

To sell our toys, we need to build a system of promotion and marketing. For this purpose, we can use traditional shops as well as online stores. For storage and transportation, we need to think about good packaging.

To perform the tasks associated with learning during the play, it is very important to have high-quality teaching materials. These materials must be complex that should include information for parents, thanks to which adults might explain a facts. It also would be useful to have a didactic material that children might use directly. These materials should be created with the participation of scientific experts, but be accessible for children.

For information that is more objective it is necessary to verify the concept with the participation of a larger number of children.

To implement the "chemical dices" concept it is necessary to develop appropriate software.

As for the material, we recommend to take plastic. It is important to use materials that are easy to recycle.

Annex 1

Table 15 - Questionnaire for experts

Name, Surname, age:

								
Do you have it?								
Do you like the color?								
Do you like the shape?								
Is this toy interesting?								
Is this toy fun?								
Is this toy useful?								
Is this toy scientific?								
Do you understand how to play?								
Do you need help of adults?								
Do you need a manual?								
Is this toy safe?								
Do you want to buy it?								
TOP 3								

Annex 2

Table 16 - Questions for the analytical forecast, part 1

Questions	Yes	%	No	%	I do not know	%
Do you like idea of the toy?						
Do you think it would be interesting toy						
Do you think it would be fun toy?						
Do you think it would be useful toy?						
Is this toy scientific?						
Would you like to buy such toy?						

Table 17- Questions for the analytical forecast, part 2

Questions	Yes	%	No	%	I do not know	%
Do you like chemistry?						
Would you like to study chemistry?						
Do you have any chemical toys?						
Do you like idea of the toy?						
Do you think it would be interesting toy?						
Do you think it would be fun toy?						
Do you think it would be useful toy?						
Is this toy scientific?						
Would you like to buy such toy?						

Appendix 1

Table 18. Age determination guidelines (Therrell 2002)

CONSTRUCTION PLAY: **BLOCKS**

Toy Characteristics	3 Years	4 Through 5 Years	6 Through 8 Years	9 Through 12 Years
Size of Parts*	Basic unit block = 3 ¼ inches square x 1 ½ inches thick Other blocks in set tend to be multiples or fractions of basic unit	----------→ ----------→ Variety in size & length of blocks	----------→ ----------→ ----------	----------→ ----------→ ----------
Shape of Parts*	Unit, double & quadruple unit Wedges, triangles, cylinders, half-rounds Simple geometric forms	----------→ ----------→ ----------→ More specialized forms	----------→ ----------→ ----------→ ----------	----------→ ----------→ ----------→ ----------
Number of Parts*	60-80 pieces	80-100 pieces	----------→	----------→
Interlocking/Loose Parts				
Materials*	Hard or soft wood Hard wood is heavier, more durable, & more expensive	----------→ ----------	----------→ ----------	----------→ ----------
Motor Skills Required	Fine-motor skills needed to handle heavier blocks	----------→ Arm & body coordination	----------→ ----------	----------→ ----------
Color/Contrast	No color (blocks only varnished)			
Cause & Effect				

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Sensory Elements				
Level of Realism/Detail	No color or complex structures	——————→	——————→	——————→
Licensing				
Classic				
Robotic/Smart Features				
Educational				
Relevant Play/Behavior	More advanced constructions than 2-year-olds Analyze component parts of what they want to build Visualize parts in relationship to the others Work through problems of size, volume, space, & weight	Even more progressed structures Dramatic story lines added to constructions. Loose parts combined with blocks	——————→ ——————→ ——————→	——————→ ——————→ ——————→
Examples of Toys	Wooden kindergarten blocks Number & letter blocks Table blocks Hollow blocks	——————→ ——————→ ——————→ ——————→	——————→ ——————→ ——————→ ——————→	——————→ ——————→ ——————→ ——————→

* One of the most influential characteristics for these toys.

соединяющиеся строительные материалы

CONSTRUCTION PLAY: **INTERLOCKING BUILDING MATERIALS**

Toy Characteristics	3 Years	4 Through 5 Years	6 Through 8 Years	9 Through 12 Years
Size of Parts*	2-3 inches	2-3 inches for more complicated designs like nuts & bolts (гайки и болты) <1 inch for simple designs like bricks (кирпичики)	Variety of very small (<1"), small (1-2") & large (2-3") pieces allow more intricate structures to be built	→
Shape of Parts	Variety of shapes	→	→	→
Number of Parts*	30-50 pieces	80-100 pieces	100 pieces or more	→
Interlocking/Loose Parts	Simple interlocking designs: snapping, screwing, press together, rods & connectors, notched logs, & nesting	→	→	→
		Interlocking cogs, slot inserts, large nuts & bolts, connecting straws, popping tubes together	→	→
			Tiny screws, nuts, bolts	→
Materials	Plastic or wood	→	→	→
		Variety in materials, such as wheels, textures, miniature people, and model trees are appealing	→	→
			All-metal parts	→
Motor Skills Required*	Children of this age have the fine-motor skills necessary to manipulate most interlocking designs	→	→	→
			Small pieces present relatively little difficulty	→
Color/Contrast				
Cause & Effect				
Sensory Elements				

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Level of Realism/Detail		Want their creations to become more realistic-looking	Want kits that produce realistic, detailed models	——→
Licensing			Theme & movie based kits hold a high level of appeal	——→
Classic	Classic building sets that use notched logs or rods & connectors	——→	——→ Snap-together model car kits	——→ Cement-based model car kits.
Robotic/Smart Features		Cannot understand how to hook up &/or use battery powered construction sets	By age 7-8, capable of sets that have moving, motorized, &/or computer chip-based components	——→
Educational				
Relevant Play/Behavior	Uses interlocking materials in intended ways, which usually involves stacking in an upward direction Has the fine-motor skills necessary to manipulate most interlocking designs Lacks the cognitive ability to follow model kit assembly directions. Enjoys open-ended materials that allow them to create their own ideas	Construction play is a dominant activity ——→ ——→ Enjoys realistic-looking materials for their creations	Finds building with interlocking pieces highly interesting, much more so than non-interlocking building sets ——→ Has cognitive abilities to follow directions & step sequence in model kits Enjoys realistic, detailed models & theme/movie based kits	——→ ——→ ——→ ——→
Examples of Toys	Snap-lock beads Smaller interlocking bricks Notched logs Sets using rods/dowels and spool-like connector pieces Work Bench Screws	——→ ——→ ——→ Large nuts & bolts	All examples from 4 Through 5 Years Sets using irregularly shaped or swiveling connector pieces Sets that build realistic, detailed, or transforming models Sets that teach concepts of simple machines like wheels & axles, gears, levers, and pulleys Snap-together model car kits Small nuts, bolts, & screws	——→ ——→ ——→ ——→ Cement-based model car kits ——→

* One of the most influential characteristics for these toys.

REFERENCES

CONCEPT

Axial forces in rotating bodies. 2015. http://energy-source.ru/glava-tri/osevie-sili.html (accessed May 10, 2015).

Chemistry for Life. 2015. http://www.acs.org/content/acs/en.html (accessed December 26, 2014).

Experimentanium. 15 January 2015. http://www.experimentanium.ru/ (accessed December 26, 2014).

Mysteries of the ordinary gyroscope. 2004-2013. http://class-fizika.narod.ru/9_posmotri7.htm (accessed May 18, 2015).

Physics in toys. Spinning Top of Thomson. 2013. http://igrushka.kz/vip79/voltom.php (accessed May 12, 2015).

Science for Kids. 06 February 2015. http://www.sciencekids.co.nz/ (accessed December 20, 2014).

SCIENCE, SIMPLE. *GETTING THE FIRE OF IODINE AND ALUMINIUM.* 17 May 2014. https://www.youtube.com/watch?t=60&v=6LynCavegF8 (accessed May 15, 2015).

Seven most amazing chemical reactions. 17 December 2013. http://buzzbee.ru/samie-effectnie-himicheskie-reakcii.html (accessed May 20, 2015).

Thoisoi. *Compilation of interesting experiments with potassium dichromate.* 01 April 2012. https://www.youtube.com/watch?v=NI5-1rpmKhM&list=PLsOMq-874J1XqEo4VvLeIgni9AvSLsQKi (accessed May 15, 2015).

—. *Liquid nitrogen - Compilation of experiments with liquid nitrogen.* 19 December 2012. https://www.youtube.com/watch?v=HwlgknbeHVo (accessed May 18, 2015).

—. *The best selection of reactions with sodium in history!* 25 April 2012. https://www.youtube.com/watch?v=fFuA8XC8tIM (accessed May 18, 2015).

Top 10 of spectacular chemical reactions. 11 June 2012. http://nibler.ru/flv/11669-10-samyh-effektnyh-himicheskih-reakciy.html (accessed May 15, 2015).

EDUCATION

Education. 10 January 2015. http://www.scientificamerican.com/education/ (accessed December 15, 2014).

Gauntlett D., Thomsen B. S. “CULTURES OF CREATIVITY.” *legofoundation.* 2015. http://www.legofoundation.com/en-us/research-and-learning/foundation-research/cultures-of-creativity (accessed April 20, 2015).

Huizinga, J. *Homo Ludens. A Study of the Play Element in Culture.* London: ROUTLEDGE & KEGAN PAUL, 1980.

“Learning through Play.” *legofoundation.com.* 2015. http://www.legofoundation.com/en-us/who-we-are/learning-through-play (accessed April 15, 2015).

«LEGO Foundation. Introduction.» *legofoundation.com.* 2013. http://www.legofoundation.com (дата обращения: 18 April 2015 г.).

Osborn, Alex. *Applied Imagination.* 1953.

Rochat, Philippe. *The meaning of play in relation to creativity.* 2012.

“The future of learning.” *The LEGO® Learning Institute.* 2013. http://www.legofoundation.com (accessed April 25, 2015).

Vakurov, Alexander. *The difference between education and training.* 13 June 2013. http://vakurov.ru/site/index.php?id=1799&Itemid=51&option=com_content&task=view (accessed April 20, 2015).

Whitebread, David. *The importance of play.* A report on the value of children’s play with a series of policy recommendations, Cambridge: University of Cambridge, 2012.

ERGONOMICS

Amaal Hm Ebrahim, Sm Reda. “Normative Data of Handgrip Strength and Hand Dexterity of Preschool Egyptian Children Aged 3-6 Years.” *Physiotherapy*, 2014: 1-14.

“Council Directive 88/378/EEC of 3 May 1988 on the approximation of the laws of the Member States concerning the safety of toys.” *European Union law.* 3 May 1988. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31988L0378 (accessed April 20, 2015).

Dictionary, American Heritage. *The American Heritage Dictionary of the English Language, 5th edition.* Houghton Mifflin, 2012.

Dreyfuss, Henry. *The Measure of Man; Human Factors in Design.* 1960.

Ferreira, Andréa Campos de Carvalho, Antonio Carlos Shimano, Nilton Mazzer, Cláudio Henrique Barbieri, Valéria Meirelles Carril Elui, and Marisa de Cássia Registro Fonseca. “Grip and pinch strength in healthy children and adolescents.” *Acta Ortopédica Brasileira*, Mar./Apr. 2011: vol.19 no.2.

IEA. 2015. http://www.iea.cc/whats/index.html (accessed April 12, 2015).

Jan Dul, Ralph Bruder, Peter Buckle, Pascale Carayon, Pierre Falzon,William S. Marras, John R. Wilson and Bas van der Doelen. “A strategy for human factors/ergonomics: developing the discipline and profession.” *Ergonomics*, 2012: 1-27.

Martin, Elizabeth A. *Concise Medical Dictionary.* Oxford University Press, 2010.

Millodot, Michel. *Dictionary of Optometry and Visual Science, 7th edition.* Melbourne : ANTHEA COCHRANE , Department of Optometry and Vision Sciences, The University of Melbourne , 2008.

Mosby's Dental Dictionary, 2nd Edition. 2008.

Mosby's Medical Dictionary, 8th edition. Mosby, 2009.

O'Toole, Miller-Keane and Marie T. *Miller-Keane Encyclopedia & Dictionary of Medicine, Nursing & Allied Health -- Revised Reprint, 7th Edition.* Camden, New Jersey: Saunders, 2005.

“Psychological peculiarities of children of 5-6 years.” *Human psychology.* 02 December 2013. http://en.psibook.com/posts/psychological-peculiarities-of-children-of-5-6-years.html (accessed April 15, 2015).

“The Consumer Product Safety Improvement Act (CPSIA) .” *Consumer Products Safety Commission.* 06 December 2013. http://www.cpsc.gov/en/Regulations-Laws--Standards/Statutes/The-Consumer-Product-Safety-Improvement-Act/ (accessed April 20, 2015).

Therrell, James A. *AGE DETERMINATION GUIDELINES: Relating Children’s Ages To Toy Characteristics and Play Behavior.* 2002.

MARKET

Edu-Science (HK) Limited. 2013. http://www.edu-toys.com.hk (accessed December 26, 2014).

Fixiki. 2011. http://fixiki.ru/ (accessed December 20, 2014).

Geek Toys. 2015. http://www.thinkgeek.com/geektoys/science (accessed January 10, 2015).

Green Toys. 2015. http://www.greentoys.com/toys.html (accessed January 15, 2015).

Green Toys Recycled Plastic Cookware And Dining Set Review. 8 August 2014. http://www.thebrickcastle.com/2014/08/green-toys-recycled-plastic-cookware.html (accessed December 26, 2014).

Inspiringtoys. 2015. http://inspiringtoys.co.uk/4m-kidz-labs-green-science-eco-science-toys (accessed January 15, 2015).

Interactive Planetarium. 2007. http://www.scientific.com.hk/product_detail.php?pid=9 (accessed December 26, 2014).

labirint. 2015. http://www.labirint.ru/genres/2010/ (accessed December 20, 2015).

Science Museum. n.d. http://www.sciencemuseum.org.uk/online_science/apps.aspx (accessed January 10, 2015).

Science4you. 2014. http://www.science4youtoys.co.uk/about-us/company (accessed December 26, 2014).

Scientific Toys - Educational Science Toys. 2015. http://www.buzzle.com/articles/scientific-toys-educational-science-toys.html (accessed January 15, 2015).

Scientific Toys. 2007. http://www.scientific.com.hk (accessed December 26, 2014).

Steve Spangler Science. 2013. http://www.stevespanglerscience.com/ (accessed December 26, 2014).

Tedco Toys. 2015. http://www.tedcotoys.com/ (accessed December 26, 2014).

THE MAN OF GAMES. 2015. http://www.clementoni.com/en/the-man-of-games/ (accessed December 20, 2014).

Toys & Games. 2015. http://store.discovery.com/toys-games/index.php?v=discovery_tech-gadgets&nvbar=Toys+%26amp%3B+Games (accessed January 15, 2015).

Znatok. 2015. http://babadu.ru/store/vendor/znatok/ (accessed December 20, 2014).

MATERIALS AND TECHNOLOGIES

Afeyan, Noubar. *Top 10 emerging technologies for 2014.* 1 September 2014. https://agenda.weforum.org/2014/09/top-ten-emerging-technologies-2014/ (accessed January 15, 2015).

Amery, Seth. *How Are Die-cast Toys Made?* . 2015. http://www.ehow.com/how-does_5150721_diecast-toys-made.html (accessed January 15, 2015).

Blog, Tinydeal. *Wooden Toys.* 11 December 2013. http://blog.tinydeal.com/2013/12/11/wooden-toys/ (accessed December 27, 2014).

Die-cast toy. 2014. http://en.academic.ru/dic.nsf/enwiki/689362 (accessed January 15, 2015).

Eco Toys. 2011. http://www.ifpaenergyconference.com/Eco-Toys.html (accessed January 10, 2015).

Fine Wood Toys for Your Children's Children . n.d. http://www.woodentoy.com (accessed January 18, 2015).

Five coolest eco friendly toys for your little ones. 2014. http://www.greendiary.com/coolest-eco-friendly-toys.html (accessed January 15, 2015).

Green Toys. 2015. http://www.greentoys.com/toys.html (accessed January 15, 2015).

Green Toys Recycled Plastic Cookware And Dining Set Review. 8 August 2014. http://www.thebrickcastle.com/2014/08/green-toys-recycled-plastic-cookware.html (accessed December 26, 2014).

Greenemeier, Steven Ashley and Larry. *9 Materials That Will Change the Future of Manufacturing [Slide Show]*. 22 April 2013. http://www.scientificamerican.com/article/9-materials-that-will-change-manufacturing/ (accessed December 26, 2014).

Innovative Materials and Technologies. 2015. http://www.mirexpo.ru/exhibitions/imtech.shtml (accessed January 15, 2015).

Wooden Toys. 2015. http://www.ehow.com/hobbies-games/toys/wooden-toys (accessed March 10, 2015).

Wooden Toys Versus Plastic Toys . 06 May 2014. http://www.blog.greenbeekids.co.uk/2014/05/why-natural-wooden-toys-beat-plastic.html (accessed January 18, 2015).

PRODUCT DESIGN

Brainstorming. 2015. http://www.mindtools.com/brainstm.html (accessed April 15, 2015).

Buchanan, Richard. *"The Convergence of Management and Design" by Richard Buchanan, Ph.D.* . 9 April 2010. https://www.youtube.com/watch?v=xpKJSvKrk7o (accessed April 10, 2015).

—. *Discovering Design: Explorations in Design Studies* . Chicago: University Of Chicago Press, 1995.

—. "Richard Buchanan: Keynote." *Vimeo.* 25 February 2011. https://vimeo.com/20379481 (accessed April 10, 2015).

Carnegie Mellon's School of Design. n.d. http://design.cmu.edu/ (accessed April 15, 2015).

Design Department at The Ohio State University. 2015. http://design.osu.edu/front (accessed May 15, 2015).

Interaction Design Association. 2009. https://vimeo.com/ixdaglobal (accessed April 25, 2015).

Norman, Donald A. *The Design of Everyday Things.* London/New York: MIT Press, 2000.

—. *The Design of Future Things.* 2009.

Osborn, Alex. *Applied Imagination.* 1953.

Papanek, Victor J. *Design for the Real World: Human Ecology and Social Change.* Chicago: Academy Chicago Publishers, 1984.

Product Design Hub. Industrial designers community and resources. б.д. http://productdesignhub.com/ (дата обращения: 17 April 2015 г.).

Sanders, Elizabeth. "Design Serving People." *Cumulus Working Papers.* Copenhagen: Publication Series G University of Art and Design Helsink, 2006. 28-33.

Souza, Clarisse Sieckenius de. *The Semiotic Engineering of Human-Computer Interaction.* 2004.

Sudjic, Deyan. *The Language of Things: Understanding the World of Desirable Objects* . W. W. Norton & Company, 2009.

Takahashi, Shimpei. *Play this game to come up with original ideas.* May 2013. http://www.ted.com/talks/shimpei_takahashi_play_this_game_to_come_up_with_original_ideas#t-1003 (accessed May 15, 2015).

SCIENCE FOR CHILDREN

Chemistry for Life. 2015. http://www.acs.org/content/acs/en.html (accessed December 26, 2014).

Creation of the Office FAjúnior. 02 February 2015. http://www.fa.ulisboa.pt/index.php?option=com_content&view=article&id=2584%3Agabinete-fajunior&catid=212%3Apress-release&Itemid=380&lang=pt (accessed December 26, 2014).

CREST Awards. 15 January 2015. http://www.britishscienceassociation.org/crest-awards/childrens-university-and-crest (accessed December 26, 2014).

Education. 10 January 2015. http://www.scientificamerican.com/education/ (accessed December 15, 2014).

Experimentanium. 15 January 2015. http://www.experimentanium.ru/ (accessed December 26, 2014).

Fixiki. 2011. http://fixiki.ru/ (accessed December 20, 2014).

Hodgkin, Deb. *Young Scientists. Doing Science with Babies, Toddlers and Kids - A Book for Parents.* Deborah Hodgkin, 2010.

Kids.gov, official web portal for kids. 02 February 2015. http://kids.usa.gov/social-studies/index.shtml (accessed December 26, 2014).

Kiss, Albert. *Albert Kiss. Scientific Children's Association in primary schools.* Zalabér, 2011.

Murano, Grace. *10 Amazing Inventions by Teens.* 24 August 2014. http://www.oddee.com/item_99064.aspx (accessed December 25, 2014).

Myhailyuta, Gennadiy. *Inventions made by children.* 09 May 2014. http://ogend.ru/nu/izobreteniya-sdelannye-detmi.html (accessed December 25, 2014).

National Science Foundation. n.d. http://www.nsf.gov/ (accessed December 25, 2014).

Science for Kids. 06 February 2015. http://www.sciencekids.co.nz/ (accessed December 20, 2014).

Science House Foundation. 2010. http://sciencehousefoundation.org/ (accessed December 26, 2014).

Science Learning. Funding schemes. 2015. http://www.wellcome.ac.uk/Funding/Public-engagement/Funding-schemes/Science-Learning/index.htm (accessed December 25, 2014).

Science4you . 2014. http://www.science4youtoys.co.uk/about-us/company (accessed December 26, 2014).

SIX is social innovation. 2015. http://www.socialinnovationexchange.org/about#about (accessed December 20, 2014).

Smith, Rene. *About Science Kids.* February 2015. http://www.sciencekids.co.nz/about.html (accessed December 14, 2014).

The Young Foundation. 2015. http://youngfoundation.org/ (accessed December 26, 2014).

TRENDS

Afeyan, Noubar. *Top 10 emerging technologies for 2014.* 1 September 2014. https://agenda.weforum.org/2014/09/top-ten-emerging-technologies-2014/ (accessed January 15, 2015).

Agarwal, Tarun. *Introduction to Screenless Displays with Their Types.* 2013. https://www.elprocus.com/introduction-to-screenless-displays-and-their-types/ (accessed December 26, 2014).

Ben 10. n.d. http://www.cartoonwatcher.com/ben10/ben10-wallpapers/ben10-wallpaper-15.php (accessed December 26, 2014).

"Ben 10 Toy Line From Bandai." *http://toynewsi.com.* 06 07 2006. http://toynewsi.com/news.php?catid=78&itemid=9823 (accessed april 10, 2015).

Cini4kin. *Iron Glass.* 10 September 2014. http://trended.ru/2014/09/steklyannoe-zhelezo-prekrasnyj-material-dlya-zashhitnogo-kejsa/ (accessed December 26, 2014).

Five coolest eco friendly toys for your little ones. 2014. http://www.greendiary.com/coolest-eco-friendly-toys.html (accessed January 15, 2015).

Gajitz » Meta » Technology. 2015. http://gajitz.com/meta/technology/ (accessed January 15, 2015).

Green Toys. 2015. http://www.greentoys.com/toys.html (accessed January 15, 2015).

Green Toys Recycled Plastic Cookware And Dining Set Review. 8 August 2014. http://www.thebrickcastle.com/2014/08/green-toys-recycled-plastic-cookware.html (accessed December 26, 2014).

Greenemeier, Steven Ashley and Larry. *9 Materials That Will Change the Future of Manufacturing [Slide Show]*. 22 April 2013. http://www.scientificamerican.com/article/9-materials-that-will-change-manufacturing/ (accessed December 26, 2014).

Innovative Materials and Technologies. 2015. http://www.mirexpo.ru/exhibitions/imtech.shtml (accessed January 15, 2015).

LEGO Products . 2015. http://www.lego.com/en-us/products (accessed December 28, 2014).

Science4you. 2014. http://www.science4youtoys.co.uk/about-us/company (accessed December 26, 2014).

Trend. 2015. http://www.merriam-webster.com/dictionary/trend (accessed December 26, 2014).

Znatok. 2015. http://babadu.ru/store/vendor/znatok/ (accessed December 20, 2014).

TECHNICAL DOSSIER